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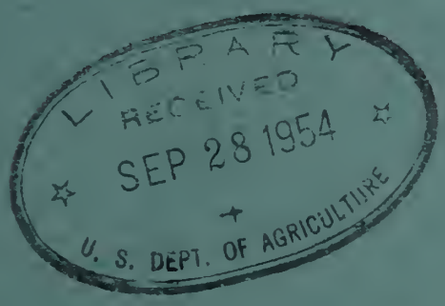
Annual Report



WESTERN SHEEP BREEDING LABORATORY

— AND —

UNITED STATES SHEEP EXPERIMENT STATION

DUBOIS, IDAHO

JUNE 30, 1942

This report of research projects not yet completed is intended for the use of administrative leaders and workers in this or related fields of research, and not for general distribution.

ANNUAL REPORT OF THE
WESTERN SHEEP BREEDING LABORATORY
FOR 1942 PAGES 1-38

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ANNUAL REPORT OF THE
U. S. SHEEP EXPERIMENT STATION
FOR 1942 PAGES 39-52

In a program which involves the improvement of sheep through breeding methods under range conditions it appears difficult to accumulate information that will permit of a large number of conclusions during a year, and particularly early in the breeding venture. The Laboratory is just rounding out its fifth year since the breeding activities got under way.

Sheep reproduce and come into maximum production very slowly compared with some of the other domestic animals. In fact the ewe lambs that were dropped in the spring of 1938 have just come into maximum production. Rambouillet sheep under range conditions develop until they are about five years of age.

It appears desirable not to draw premature conclusions. Unless otherwise stated the summaries in this report are preliminary and subject to change as the data increase.

ANNUAL REPORT
Western Sheep Breeding Laboratory
June 30, 1942

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DIRECTORS OF STATE AGRICULTURAL EXPERIMENT STATIONS OF THE TWELVE WESTERN STATES THAT ARE COLLABORATING WITH THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA:	P. F. Burgess, University of Arizona, Tucson.
CALIFORNIA:	C. B. Hutchison, University of California, Berkeley.
COLORADO:	H. J. Henney, Colorado State Agricultural College, Fort Collins.
IDAHO:	E. J. Iddings, University of Idaho, Moscow.
MONTANA:	Clyde McKee, Montana State College, Bozeman.
NEVADA:	S. B. Doten, University of Nevada, Reno.
NEW MEXICO:	Fabian Garcia, New Mexico State College of Agriculture, State College.
OREGON:	W. A. Schoenfeld, Oregon State College, Corvallis.
TEXAS:	A. B. Conner, Agricultural and Mechanical College of Texas, College Station.
UTAH:	A. H. Walker, Utah State Agricultural College, Logan.
WASHINGTON:	E. C. Johnson, Washington State College, Pullman.
WYOMING:	J. A. Hill, University of Wyoming, Laramie.

COLLABORATORS OF THE WESTERN SHEEP BREEDING LABORATORY

ARIZONA: Ernest B. Stanley, Head, Department of Animal Husbandry, College of Agriculture, University of Arizona, Tucson.

CALIFORNIA: James F. Wilson, Division of Animal Industry, College of Agriculture, University of California, Davis.

COLORADO: Ivan Watson, Department of Animal Industry, Colorado State College of Agriculture and Mechanics Arts, Fort Collins.

IDAHO: C. W. Hickman, Head, Department of Animal Husbandry, College of Agriculture, University of Idaho, Moscow.

MONTANA: Richard T. Clark, Head, Department of Animal Husbandry, Montana State College, Bozeman.

NEVADA: Charles E. Fleming, Department of Range Management, College of Agriculture, University of Nevada, Reno.

NEW MEXICO: Philip E. Neale, Department of Animal Husbandry, New Mexico College of Agriculture and Mechanics Arts, State College.

OREGON: Ray G. Johnson, Department of Animal Husbandry, Oregon State Agricultural College, Corvallis.

TEXAS: Bruce L. Warwick, Department of Animal Industry, Texas Agricultural and Mechanical College, College Station.

UTAH: Fredrick F. McKenzie, Head, Department of Animal Husbandry, Utah State Agricultural College, Logan.

WASHINGTON: M. E. Ensminger, Head, Department of Animal Husbandry, State College of Washington, Pullman.

WYOMING: Fred S. Hultz, Head, Department of Animal Production, College of Agriculture, University of Wyoming, Laramie.

WESTERN SHEEP BREEDING LABORATORY AND U. S. SHEEP EXPERIMENT STATION,
Dubois, Idaho, as of June 30, 1942

Name	Rating	Date entered on duty	General Duties
Nordby, Julius E.,	Principal Animal Husbandman, P-6	Mar. 1, 1938	Director
Smith, Stanley L.,	Animal Husbandman, P-4	Oct. 1, 1935	Construction & Maintenance
Terrill, Dr. Clair E.,	Animal Husbandman, P-4	July 3, 1936	Geneticist, physiologist
Stochr, John A.,	Assoc. Animal Husbandman, P-3	Aug. 28, 1928	Flockmaster
Pohle, Elroy M.,	Assoc. Animal Fiber Technologist, P-3	May 2, 1938	Wool technologist
Sidwell, George M.,	Jr. Animal Husbandman P-1	July 1, 1941	Assistant, Physiology and genetics
Emik, L. Otis,	Jr. Animal Husbandman P-1	July 7, 1941	Assistant, Physiology and genetics
Keller, Henry R.,	Jr. Animal Husbandman P-1	Oct. 16, 1941	Assistant, wool laboratory.
Schaefer, Chester F.,	Assistant Clerk, CAF-3	June 22, 1936	On military leave
Harrison, Raymond H.,	Assistant Clerk, CAF-3	Oct. 25, 1937	Clerk
Pohle, Ruth K.,	Jr. Clerk-typist, CAF-2	June 1, 1942	Assistant Clerk
Jeffery, Lee C.,	Foreman of Farm Laborers, CU-4	June 7, 1924	General maintenance pumps, equipment
Hohman, Max E.,	Farm Laborer, CU-3	Apr. 1, 1935	Shepherd
Rasmussen, Henry, Jr.,	Farm Laborer, CU-3	July 1, 1926	Farm laborer
Landacre, Harold E.,	Farm Laborer, CU-3	Apr. 6, 1939	Truck driver, general maintenance
Goldman, James R.,	Farm Laborer, CU-3	May 1, 1939	Shepherd
Phillips, Walter H.,	Truck Driver, CU-2	Mar. 16, 1935	Truck driver
Powell, Fred A.,	Jr. Farm Laborer, CU-2	May 1, 1935	Teamster
Landacre, David N.,	Jr. Farm Laborer, CU-2	Apr. 8, 1940	Truck driver
Hoopes, Wendell L.,	Jr. Farm Laborer, CU-2	Apr. 16, 1941	Farm laborer
Payne, Jesse L.,	Jr. Farm Laborer, CU-2	Mar. 18, 1941	Shepherd
Applegate, Ivan F.,	Jr. Farm Laborer, CU-2	Nov. 10, 1941	Farm laborer
Gibbs, John H.,	Jr. Farm Laborer, CU-2	Apr. 1, 1941	Teamster
Rawson, Thomas A.,	Jr. Farm Laborer, CU-2	Mar. 23, 1942	Shepherd

ROSTER OF PERSONNEL (Continued)

Name	Rating	Date entered on duty	General Duties
Blair, Joseph F.,	Jr. Farm Laborer, CU-2	Mar. 25, 1941	Shepherd
Jenks, Newel A.,	Jr. Farm Laborer, CU-2	Apr. 11, 1942	Shepherd
Smajla, Ivan	Jr. Farm Laborer, CU-2	Apr. 21, 1942	Shepherd
Nantz, Mrs. Dorinda R.,	Unskilled Laborer	June 16, 1941	Janitress & cook

STUDENT EMPLOYMENT

Name	College	Time employed
George C. Hughes	Montana State College	6-13 to 9-12-38
Glenn J. Spaulding	Washington State College	6-12-39 to 9-14-40
Gerald L. Crow	Colorado State College	6- 5 to 9- 4-39 5-28-40 to 8-27-40
Thomas D. Watkins, Jr.	University of California	5-28-40 to 8-27-41
George W. Sidwell	Utah State College	9-25-40 to 6-30-41
William L. York	University of Idaho	5-19 to 8-18-41
Raleigh E. Patterson	Texas A & M College	6-16 to 9-15-41
C. LeRoy Rainville	University of Arizona	6- 2 to 9-12-41
Sylvester E. West	University of Wyoming	6-13 to 9-12-41
Charles E. Childs	University of Arizona	5-25 to 8-24-42
S. Clark Martin	University of Arizona	5-25 to 7-3-42*
Clarence L. Bell	University of Arizona	6-20 to 9-19-42
I. Frederick Roberts	Utah State College	7-1 to 9-5-42

*Withdrew to accept fellowship in the Department of Forestry, University of California.

PHYSICAL PLANT

The physical plant that is now available comprises 46,202 acres of seasonal grazing lands, and summer grazing permits on the Targhee National Forest for about 1000 mature sheep plus winter grazing permits on the Salmon National Forest for 2000 mature sheep. The building facilities involve one main laboratory, one experimental barn, lambing and shearing shed, horse barn, machine shop, four garages, 10 dwellings and one pump house.

Improvements and additions to the facilities during the year involve two new cottages (included above), range road construction, fire lines, a new dipping vat with necessary facilities, fence reconstruction, and an addition to the machine shop. Roads at headquarters were also graded and gravelled and some flag stone curbs installed. Water facilities on the high ranges, including the installations of 3 water troughs, were also improved.

SIGNIFICANCE OF PROBLEM

The range sheep industry of the twelve western states involves approximately 33,000,000 head of sheep producing annually in round figures in the neighborhood of 275,000,000 pounds of wool or somewhat more than two-thirds of the nations supply. Approximately 65 percent of the nations lamb tonnage also originates within this area. These estimates involve both fat and feeder lamb tonnage, but do not include the weight that is added to western feeder lambs in cornbelt feed lots. These sheep, western cattle and horses harvest the annual crop from approximately 394 million acres of public domain, state lands, National Forests and Indian reservations together with millions of acres of privately owned grazing land, and consume each year a vast tonnage of roughages, concentrates and farm by-products that are characteristic of western agriculture and essential to its success.

Sheep breeding on western ranges lacks stability with reference to definite ideas that should characterize wool type within areas and particularly within flocks. Admixture of breeding characterize a very large portion of range flocks. Lack of uniformity in the breeding of the rams that are selected for use from year to year, and the inability to get an adequate supply of efficient rams, are, in large part responsible for this condition. The average mature ewe in the 12 western states produces only approximately 8½ pounds of unscoured wool. The average annual production of wool of the Laboratory Rambouillet flock that is maintained under average western range conditions is two pounds higher. This would indicate that there is room for improvement in the western fine-wool clip through attention to breeding.

This Laboratory, therefore, has some significant tasks ahead. Western ranges are adapted, in general, to the production of fine, half-blood, three-eights, and, in some areas, to quarter blood wool. These four grades

are now being produced by the Rambouillet, Targhee, Columbia and Corriedale flocks of this Station all of which are being genetically purified through a carefully directed inbreeding program. This program is directed toward the production of not only maximum yield in wool and lamb, but for stability in wool type or quality to the end that they will reproduce with satisfactory economic efficiency the type of body and quality of wool which must characterize utility sheep. A very large percentage of the western range flocks produce wool within each flock that varies from fine to quarter blood. In general, the various grades are being marketed as a "bulk" lot without grading at the point of origin and consequently all grades of wool may be found in the same bag, thus making it impossible to appraise quality or shrinkage with any reasonable degree of accuracy, and consequently the wool market affords very little encouragement as a specialized market with reference to quality at the point of origin. While it is true that this Laboratory has for its objective the improvement of sheep through the application of breeding methods, it appears that this objective cannot possibly supply the ultimate answer unless all public institutions concerned with sheep and wool improvement in the west do their utmost in the best way they can to bring about a better understanding of quality to the end that the wool trade, primitive as it now is, will have to recognize a disciplined appreciation of values at the point of origin so the producer will be in a far more advantageous position than he is now to know values.

Grade Rambouillet sheep comprise the great bulk of the sheep in the range country of the west that produce fine wool. Their popularity is well understood since the bulk of all original bag wools originating in the west is fine wool. These grade Rambouillets are maintained in a very high heterozygous condition. This heterosis is desirable for commercial production in that it usually is associated with more vigorous lambs. The existing heterosis comes about largely by (1) using rams that are in themselves heterozygous, (2) by varying the source of rams from time to time or by both methods. The maximum effective heterosis, however, cannot be realized in this manner. But it has until recently been the only means available to the ranchman which would permit him to retain fine wool sheep. A number of the breeders of purebred range and stud Rambouillet rams are doing some inbreeding in their flocks. However, they can likely not undertake a very intensive program of inbreeding because of its long time nature. But even slight inbreeding will prove of some value if it is pursued in a systematic manner. The heterozygosity which prevails explains in large part the variability in wool and body type that occurs.

Any improved system of breeding must hold out immediate encouragement to the producer who can ill afford to jeopardise his income. He is concerned with increased quantity as well as quality in a uniform population with the minimum of variation. This is a big order. It is a challenge to any improved breeding method, and obviously it will be met only when the transmitting ability for these qualities become a genetic reality. It can become a genetic reality only through the persistent effort to purify the gene pattern by eliminating, through a systematic method of inbreeding, the recessive undesirables. Such a plan of breeding also brings about divergence,

PROJECT SUMMARIES FOR 1942.

PROGRESS OF INBREEDING

The average inbreeding coefficient of all live lambs born from 37 lines in 1942 was 7.73. The lambs from the most inbred lines had a coefficient of 25 percent, 12 lines had a coefficient between 12.5 and 25 percent and 11 lines between 6.25 and 12.50 percent. The rate of reproduction is slow in sheep and the inbreeding coefficient increases accordingly. (page 14).

INBREEDING IN RAMBOUILLETS

In an analysis of the date from 272 yearling ewes significant relationships were found between inbreeding coefficients and fleece weight, staple length, body weight, type score and neck folds. (For details see pages 14-15).

EFFECT OF OUTCROSSING INBRED EWES

The yearling progeny of this outcross had .4 pound heavier fleeces than their dams and 3.5 pounds heavier bodies. They had slightly lighter fleeces and definitely heavier bodies than the inbred yearling offspring from their line. However, the ewes involved in the outcross were 7.6 pounds, or 9 percent lighter than were the dams of the inbred yearlings (page 15).

SELECTION OF RAMBOUILLETS IN INBRED LINES

Selection is aimed at the elimination of all animals of low quality as early as possible in life and the retention of all others. The number of yearling ewes equal to about 56 percent of the live ewe lambs born in one year must go into breeding each year to maintain the flock under range conditions that obtain at this Laboratory (pages 15-16-17).

SOME PROBLEMS IN DEVELOPMENT OF INBRED LINES

From data accumulated so far it appears that the increase in inbreeding will be slow as it ranges from 1 to 3 percent a year. Tjis is due to a slow reproductive rate in sheep. To increase this rate would necessitate a corresponding decrease in selection. It does not appear necessary to increase the number of ewes in a line beyond thirty (page 17).

HERITABILITY OF FLEECE AND BODY CHARACTERISTICS IN RAMBOUILLETS.

An analysis of daughter-dam comparisons of 1178 yearling Rambouillet ewes has been made. The average increase in the daughters for each unit of increase in the dams varied from 0.09 to 0.24 pounds of grease weight of fleece, from 0.13 to 0.23 centimeters of staple length and from 0.10 to 0.25 pounds for body weight. The average increase in clean weight of wool of the daughters was 0.16 pound for each pound increase in the clean weight of wool of the dams, based on one year's data only. The estimates of heritability were 27 percent for grease fleece weight, 30 percent for staple length and 39 percent for bosy weight (page 18)

PROGENY TESTING

On the average, from all rams kept to one year or more of age for each line, one was used for breeding, one was tested, two held in reserve, one or both of which had been progeny tested and three rams were sold (page 18).

CHANGES IN RECORDS TAKEN

The density index, density score, fleece character score, back score, rump score and leg score have been discontinued. The latter three are included in the more general type score and the three former proved of very little value (pages 19-24).

FACE COVERING

About 11 percent of all Rambouillet lambs had open faces in 1942 at weaning time. 40 percent had partially covered faces and 49 percent had wool covering over the entire face. A breeding plan to increase the open face character in all lines is now under way (page 24).

SKIN FOLDS

At weaning time in 1939 and 1940, 66 percent of the lambs were free from folds compared with 72 percent free from folds in 1941 (page 24).

HORNS IN RAMBOUILLETS

Two lines have been started with a view of developing the polled character (page 25).

ABNORMAL LAMBS IN RAMBOUILLETS

Approximately 2 percent of the Rambouillet lambs born in 1942 had black spots in the wool. There were two cryptorchid lambs out of 701 rams born in 1941 (page 25).

CLEAN WOOL YIELD DETERMINATIONS

840 wool samples and 5 half fleeces of the Rambouillet breed have been scoured during the year for determining clean wool yield (page 25)

METHODS OF MEASURING WOOL QUALITY

1400 wool samples have been analyzed for quality by means of the cross-section method (page 25).

WOOL CHARACTERS FOR 1941

The mean staple length for 1941 was approximately 6 cm. or 2-1/4 inches, with a maximum length of 3-1/4 inches. Clean yield for the year was 41.37 percent and an average clean fleece weight of 3.86 pounds (pages 25-27).

COOPERATIVE COMMERCIAL SHRINKAGE RESULTS

In a commercial scouring test involving 20 bags (5974 lbs.) of wool selected at random in equal number from the Rambouillet, Targhee, Columbia and Corriedale breeds it was determined that the shrinkages were respectively 57.4, 52.7, 48.8 and 47.6 percent, or appreciably below the estimated shrinkage placed on the total clips from these breeds by the agency selling the clip (pages 27-29).

CLEAN YIELD RESULTS OF LONG AND SHORT STAPLE RAMBOUILLET WOOL

One bag (30 fleeces) of wool (6.29 cm. average length) from a long staple line of Rambouillets had a shrinkage 3.5 percent lower than one bag (33 fleeces) of Rambouillet wool averaging 5.11 cm. in length. The former weighed .7 pounds more per fleece in the grease and yielded .67 pounds more clean wool per fleece than the latter. Long staple wool shrinks less in Rambouillets than short wool (page 29).

STAPLE LENGTH IN RELATION TO WOOL PRODUCTION

It has been determined from an analysis of 206 Rambouillet yearling ewe fleeces that they had an unadjusted fleece length of 6.59 cm., 3.52 pounds of clean wool, and that for each increase of one centimeter in staple length, there was an increase of one-half pound of clean scoured wool and 2.5 percent increase in clean yield (page 30).

SAMPLING STUDIES

8 areas are being studied to test the accuracy of present fleece sampling methods. This study was undertaken in 1941 (page 30).

MOISTURE IN GREASE WOOL

The moisture content of Rambouillet wool appears to be about one percent less at this Laboratory than it is on the same wool in Washington, D.C. (page 31).

HAIRINESS IN FLEECES

Lambs from some rams apparently show a higher percentage of hairiness than they show from other rams (page 32).

REPRODUCTIVE CAPACITY OF RAMS AS INDICATED BY SEMEN TESTS

Fertility in rams in the fall of 1941 appears a little low. The analysis of semen tests appears to be consistent with ability to successfully impregnate ewes. It is thought that this low fertility may have been due to freezing of the green feed early in the fall of 1941. However, deficiency appears to be typical for one line of breeding (pages 32-33).

METHODS OF EVALUATING RAM SEMEN

Improved methods of evaluating semen are being developed. The reliability of the opal blue staining method was verified and some adaptations for its use were made. The routine staining method was improved by using pH controlled iron haematoxylin and by mass staining methods which allowed the staining of 20 slides at a time with very uniform results (pages 33-34).

REPRODUCTIVE DEVELOPMENT OF RAM LAMBS

A significant correlation has been found between the weights of Cowper's gland, thyroid, pituitary, testicles and body weight. Semen tests have been obtained from ram lambs down to 236 days of age, and concentrations of sperm above 1,000 million per c.c. have been found in the epididymis and ampulla down to 200 days of age (pages 34-35).

WEATHER

Wool and lamb production under range conditions vary more or less from year to year according as weather conditions change (page 35).

RAMBOUILLET RAMS LOANED TO COOPERATIVE STATIONS

Records for this project have not reached this Laboratory for 1942 (page 36).

Summary of Ewes in Breeding Pens - Special Research Project
1941-42 Breeding Season

Pen No.	Ram No.	No. of ewes	Type score	Yearling body wt. (lbs.)	Adj. fl. wt. (lbs.)	Adj.fl. length (cms.)	Inbreeding coefficient	
							Dams	Offspring
18	3854R	16	2.42	79.81	9.07	5.61	22.65	28.71
18-	438WP	13	2.64	78.85	7.59	4.80	27.90	0
19	3901R	22	2.18	87.86	9.76	5.52	16.21	16.55
20	142RW	12	2.20	86.75	10.17	6.18	5.96	17.23
20-	2109W	15	2.58	85.60	9.56	6.15	3.59	11.84
21	88-RW	28	2.38	88.00	10.04	6.78	3.75	13.92
22	179RW	28	2.52	87.46	10.17	6.07	7.12	11.20
23	3382R	24	2.40	84.33	9.15	5.78	6.63	19.94
24	476RW	27	2.32	87.59	10.08	5.92	9.02	17.15
25	2808W	29	2.46	88.14	9.66	5.79	0.90	8.36
26	K253	25	2.40	90.12	10.19	5.71	1.00	7.50
27	556RW	26	2.35	92.19	10.08	5.97	9.29	14.70
28	7174E	27	2.42	95.11	9.49	5.73	0.99	18.23
29	466WP	26	2.46	86.31	9.88	5.71	0.32	0
30	460RW	24	2.45	85.83	9.57	5.93	5.78	14.36
31	3406R	13	2.20	86.92	9.07	5.98	13.96	15.02
31-	2251W	22	2.06	89.59	8.67	5.79	2.84	12.35
32	542RW	24	2.36	87.42	10.36	5.85	4.95	12.50
33	30-RW	24	2.42	86.33	9.83	5.81	3.08	9.26
34	120RW	20	2.43	86.15	9.26	6.44	10.63	21.35
35	2035	30	2.41	90.10	8.78	5.50	1.67	8.34
36	2260W	25	2.45	91.58	9.42	5.76	1.50	10.26
37	3773R	29	2.26	84.48	9.12	6.29	2.54	21.91
38	2498W	24	2.58	86.04	9.40	5.59	0.34	0
38-	2498W	15	2.64	84.47	9.26	5.75	2.81	0
39	2398W	26	2.55	86.12	9.03	5.80	1.92	4.89
40	2539W	25	2.54	91.44	9.94	5.58	0	5.64
40-	2539W	17	2.49	84.24	9.42	5.79	3.02	0.34
41	2016W	27	2.49	86.74	9.39	5.69	1.85	7.41
42	2222W	27	2.54	86.59	9.34	5.57	0.07	2.55
43	1227	27	2.41	87.37	9.44	5.62	0	10.17
44	3843R	26	2.60	87.31	9.97	5.60	0.30	8.00
45	438WP	24	2.61	91.13	10.21	5.40	0	0
46	9384	25	2.41	91.64	10.03	5.69	0.20	6.37
47	2219W	24	2.64	89.74	10.01	5.60	0.53	0.56
47-	2219W	17	2.55	84.24	8.68	5.63	2.64	1.90
48	250RW	25	2.57	89.00	9.81	5.65	0.05	0.58
49	2533W	24	2.44	93.58	10.29	5.56	0	0.65
50	2390W	27	2.32	87.14	9.40	5.90	1.85	7.87
51	3774R	30	2.44	90.60	10.18	5.57	0.41	6.22
51-	3774R	14	2.50	79.86	8.95	5.77	15.00	4.32
52	15-RW	6	2.39	88.00	9.83	6.33	10.15	2.60
52-	15-RW	19	2.39	81.89	8.99	5.44	12.61	1.28
53	438WP	25	2.56	86.04	9.67	5.60	0	0
54	466 P	20	2.45	89.15	9.05	5.88	0	0
	TOTAL	1023	2.44	87.69	9.58	5.78	3.95	8.62

Development of Special Research Breeding Program 1937-1942

Year bred	Potential inbred lines	Test pens	Overshot pens	Total pens	Total ewes
1937	20	12	1	33	765
1938	22	37	1	60	1336
1939	34	30	2	66	1511
1940	36	33	2	71	1627
1941	37	35	2	74	1859

		Inbreeding coefficients in percent			
Year lambed	Potential inbred flocks	Ave. of progeny	Increase daughters over dams	Highest for any pen	Highest for any individual
1938	20	3.92	2.83	13.30	37.9
1939	22	7.24	4.05	30.29	58.3
1940	34	8.25	4.70	32.58	58.3
1941	36	8.56	5.85	31.17	47.3
1942	37	8.62	4.67	28.71	39.9

The average inbreeding of the progeny is rising. However, due to the change of rams there is necessarily some oscillation from year to year. The inbreeding has not so far brought out many defective characteristics. In the more inbred lines there are incidental cases of overshot jaw defects, some black spotting, and some lambs with hairiness. There are no apparent cases of loss of vitality. In two flocks, namely 18 and 19, there is loss in weight but not conspicuous loss in vitality. There appears to be some divergence taking place within the various flocks. Some flocks are showing a high yield of clean wool. Others are high in body weight and still others appear to be producing uniformly long staple. The inbreeding has not gone far enough to make any definite statement with reference to specific divergence.

which, if and when it occurs, makes the individuals involved increasingly successful for outcrossing to produce maximum controlled heterosis.

Not all inbreeding efforts will likely be successful. The success of such efforts will, in general, be in proportion to the purity of the gene pattern for good genes when the venture is undertaken. But inasmuch as this breeding method is the only known practical solution to a gene purification program, some failures due to undesirable genotypes which cannot be detected in the foundation material will have to be expected.

Inbreeding is used at this Laboratory in order to concentrate during the least possible time the desirable characters such as the most acceptable market form of lambs, and the production of an increased quantity as well as quality in wool. The characteristics in sheep that are of greatest economic value in range production are given the most emphasis in the breeding program.

In the pursuit of the above objectives the following studies are involved and are recognized as research lines:

RESEARCH LINE PROJECTS

1. Development of systems of breeding for locating strains of Rambouillet sheep which may possess combinations of genes that will improve strains with which they may be crossed. This research line project includes:
   (a) The development of inbred strains or lines by the mating of animals as closely related as possible or desirable, and with emphasis on selection for all characters of economic importance.
   (b) The development of inbred lines with special reference to very important characters that are of economic importance to range sheep, such as mutton form, length of staple, and faces that are free from excess wool covering causing wool blindness.
2. Determination of the inheritance of various undesirable characteristics of Rambouillet sheep, such as defective jaws, abnormalities in the growth of wool, hairiness in fleeces of wool and excessive skin folds or wrinkles, for the purpose of developing methods of breeding by which these undesirable characteristics may be eliminated from the stock.
3. Studies in the physiology of reproduction of Rambouillet sheep as they may contribute to the program of the Western Sheep Breeding Laboratory, including
   (a) Sexual maturity of Rambouillet ram lambs,
   (b) Quality of semen in relation to fertility, and
   (c) Factors affecting fertility of ewes.
4. Studies in the physiology of wool production of Rambouillet sheep including reference to fiber uniformity within and between various regions of the fleece in relation to the total uniformity of the fleece.
5. Analysis of records of the characteristics of sheep and wool to determine the usefulness of such records in the program of the Western Sheep Breeding Laboratory.

PROGRESS OF INBRED LINES

Offspring were born in 1942 from 37 inbred lines of Rambouillets. The average inbreeding coefficient for all live lambs born was 7.73 percent. Offspring from 1 line had an average coefficient of inbreeding over 25.00 percent, 12 lines were between 12.5 and 25 percent, and 11 lines were between 6.25 and 12.50 percent. In 5 of the remaining 13 lines, no inbreeding has yet occurred. Many of the lines show little increase in inbreeding over last year in spite of the fact that more of the ewes were related to the rams in each line. This was due in general to the fact that a considerable number of sons are now taking the place of the original rams.

In the 37 inbred lines, about 11 percent of the ewes were mated to their sires, 26 percent to their half-brothers, and 23 percent to less closely related rams. About 40 percent of the ewes were not related to the rams to which they were mated.

The first 6 lines for each of the more important characters are listed in the following table. These ratings are based on the averages from yearling ewe offspring of 34 lines numbered from 18-51 evaluated in 1941.

Character	Rank of Line					
	1	2	3	4	5	6
Body weight	40	47	28	35	29	26
Body type	28	24	30	41	23	26
Clean fleece weight	32	47	46	38	21	44, 37
Staple length	21	22	50	47	34	37
Open face	40	51	20	47	35	44
Freedom from folds	37	28	21	23	25	22

About two-thirds of the 34 lines are included in the above table. This indicates that the majority of the lines are outstanding in one or more characters. Ten lines appear more than once and 4 lines appear 3 or more times (21, 28, 37, 47). Of the 12 lines not represented in the above table the sires in all but 2 have been recently changed to more promising rams.

INBREEDING IN RAMBOUILLETS

Preliminary investigations have been made on the effect of inbreeding on the more important fleece and body characters based on 272 yearling ewes evaluated in 1941. Significant relationships were found between inbreeding coefficients and fleece weight, staple length, body weight, type score and neck folds as shown by the average correlation and regression coefficients within sire progenies. All relationships were inverse with the exception of that for neck folds.

These data show that for each percent increase in the inbreeding coefficient there was an average decrease of 0.05 pounds in fleece weight, 0.01 centimeter in staple length and 0.37 pound in body weight. For type

score there was an increase of 0.01 score with each increase of one percent in inbreeding which means a decrease in desirability of mutton conformation. For neck folds there was an average decrease of 0.01 score for each increase of one percent in inbreeding. This means that in general as they become more inbred they become smoother. This is reasonable as the majority of the flock is fairly smooth and therefore inbreeding would be more apt to fix the characters for absence of skin folds. There was no definite relationship between inbreeding and face covering.

Characters of economic importance such as fleece weight, fleece length and body weight in general show a slight but significant decline with increased inbreeding. However, a few lines give promise of improvement with inbreeding for one character. It is too early yet to be certain of trends within any but a few of the more advanced lines.

EFFECT OF OUTCROSSING INBRED EWES

Eight yearling ewes resulting from the cross of a purchased ram to a group of inbred ewes were evaluated in 1942. The mothers of these ewes had an average inbreeding coefficient of about 30 percent and had shown a definite decline in fleece and body weights over the original non-inbred ewes with which the line was formed. These offspring had 0.4 pound heavier fleeces than their dams and 3.5 pounds heavier bodies. They had slightly lighter fleeces and definitely heavier bodies than the inbred offspring from their line. The dams of the outcross offspring were 7.6 pounds or 9% lighter as yearlings than the dams from the inbred line. After the effect of the lower body weights of the dams on their reproductive ability has been roughly accounted for, it appears that the outcross offspring have recovered most of the loss due to inbreeding in the mothers.

SELECTION OF RAMBOUILLETS IN INBRED LINES

Data on reproduction and selection from inbred lines of Rambouillet sheep during the first 4 years of the inbreeding program are shown in table on the next page. The selection practiced in this flock is aimed at the elimination of all animals of low quality, or with defects, as early in life as possible and the retention of all others as long as they live, except for deficiencies which show up later in life, such as unsoundness, low fertility, etc.

The number of live lambs born is slightly greater than the number of ewes bred, and the number of male lambs is practically equal to the number of female lambs. Ewe lambs still present at weaning represent 40.6 percent of the number of ewes bred. This reduction of ewe lambs from birth to weaning equal to 10 percent of the ewes bred is due entirely to lamb losses. Selection of ewe lambs at weaning time and losses from weaning to yearling age further reduces the number of ewe offspring at yearling age to 35.1 percent of ewes bred. This may be reduced to about 27 percent at breeding time if a constant number of ewes is maintained. Thus the number of ewe offspring which may be culled from weaning to first breeding is about one-third of the ewe lambs weaned.

Data on Reproduction and Selection from Inbred Lines of Rambouillet Sheep.

Year Bred	No. of potential inbred lines*	Ewes bred	Ewes bred per line	Number of offspring per 100 ewes bred **						Average offspring present per line**			
				Males			Females			Males		Females	
				Alive at birth	of weaning age	of yearling age	Alive at birth	of weaning age	of yearling age	of weaning age	of yearling age	of weaning age	of yearling age
1937	34	796	23.4	52.0	36.4	18.5	53.6	40.3	37.1	8.5	4.3	9.4	8.7
1938	34	793	23.3	50.7	30.4	19.4	50.8	37.2	33.8	7.1	4.5	8.7	7.9
1939	34	805	23.7	50.9	37.8	12.2	48.3	42.0	36.0	8.9	2.9	9.9	8.5
1940	34	850	25.0	50.9	37.4	14.9	49.8	42.8	33.6	9.4	3.7	10.7	8.4
Average	34	811	23.9	51.1	35.5	16.2	50.6	40.6	35.1	8.5	3.9	9.7	8.4

* Some of these lines functioned as test pens for part of this period and two lines included in 1937 were not made a part of the Laboratory program until 1938.

** Only offspring which are potentially useful for selection purposes are included, and therefore these data do not represent total lamb production for commercial purposes.

The number of yearling ewes equal to about 56 percent of the live ewe lambs born in one year must go into breeding each year.

Some ram lambs are culled (castrated) before weaning, leaving the number of ram lambs present at weaning equal to 35.5 percent of the ewes bred to produce them or 31.7 percent of ram lambs born alive. The rams used in breeding in one year represent about 8.2 percent of the live ram lambs born in one year if only one ram is used in each line. If a ram is used more than one year this figure is reduced accordingly. Actually, however, after the lines are well underway, the ram used is selected from rams born over an average period of about 4 years, as the average ram's lifetime is about 5.5 years under Dubois conditions. Therefore, a ram used in one line in one year represents about 2 percent of the live ram lambs born from which he was selected and about 1 percent of the matings made to produce him.

SOME PROBLEMS IN THE DEVELOPMENT OF INBRED LINES OF RANGE RAMBOUILLET SHEEP

A study is underway for the purpose of examining the more important details involved in the establishment of inbred lines of range sheep. Experience in the early years of this inbreeding program has shown that the increase in inbreeding within lines will be very slow, probably ranging from 1 to 3 percent each year with an average increase per year between 1 and 2 percent. This slowness of inbreeding in range sheep is due primarily to a low reproductive rate. Any attempt to speed up the increase in inbreeding will necessitate a corresponding decrease in selection. Selection is more effective for the male parent and emphasis is placed on the selection of the ram to head each line. The rate of inbreeding increases with the number of years each successive sire is used in a given line and this in turn depends mainly on the merit and longevity of each sire.

It is believed that we should attempt to develop the maximum number of inbred lines that our facilities will support which will allow adequate numbers of ewes per line to accomplish our purpose. Increasing the number of ewes per line above the present number of 25 to 30 would have little effect on the rate of selection of ewes or on the increase of inbreeding in the line. However, it would increase the effectiveness of the selection of rams by increasing the number of rams from which only one would need to be selected. It is doubtful, however, if this would be of any real benefit when the entire program is considered.

Some increase in the precision of comparing progenies can be expected by increasing the number of ewes per line. For characters such as yearling body weight, body type score, fleece weight and staple length, it appears that it will not be practical to attempt to obtain more than about 10 to 12 yearling ewes per sire. This would require about 30 ewes in each breeding group.

HERITABILITY OF FLEECE AND BODY CHARACTERS OF RAMBOUILLET SHEEP

Studies are underway on the heritability of fleece and body characters based on daughter-dam comparisons of 1178 yearling Rambouillet ewes, born over a 3 year period from 1938 to 1940. Correlations and regressions of daughters with dams have been worked out on a within-year, within-sire basis. Highly significant relationships were found in most cases for fleece weight, fleece length, and body weight. The average increase in the daughters for each unit of increase in the dams varied from 0.09 to 0.24 pound of grease weight of fleece, from 0.13 to 0.23 centimeter of staple length, and from 0.01 to 0.25 pound for body weight. The average increase in clean fleece weight of the daughters was 0.16 pound for each pound increase in clean fleece weight of the dams, based on one year's data only. Preliminary estimates of heritability, or the proportion of the variance among the records of the dams which was due to additively genetic differences between these ewes, were obtained by doubling the average within-year, within-sire regression coefficients. Thus, estimates of heritability were 27 percent for grease fleece weight, 30 percent for staple length and 39 percent for body weight.

Highly significant daughter-dam correlations and regressions were obtained for face covering and skin folds. Low daughter-dam correlation and regression coefficients were found for body type score and only those for one group were significant. Low daughter-dam relationships were also found for fleece character score, fleece density score, density index, condition score, back score, rump score and leg score.

PROGENY TESTING OF RAMBOUILLET SHEEP

Progeny test results have been obtained on 135 sire progenies during the year. Of these 66 were based on daughter-dam comparisons on data taken on yearlings, and 69 were preliminary results based on data from weanling offspring. In evaluating results of progeny tests emphasis has been placed on body weight, mutton type, fleece weight, length of staple, face covering, and skin folds. The first four characters are given equal weight, or 20 percent each, and the latter two are given one-half as much weight or 10 percent each. The same procedure is followed at weaning time, except that fleece weight cannot be included. Ratings made on each sire group at weaning time are also used in evaluating the sire. Other characters have been observed and considered but have been given only minor emphasis.

Twelve of the 31 rams, from which final progeny test results from test pens were obtained in 1941, have been used in lines. Three rams have already been used in lines of the 31 rams from which preliminary progeny test results from test pens were obtained in 1941. All three of these weanling progenies had been given the highest rating.

Only the best rams (as judged by their own records for fleece and body characteristics) are given an opportunity to be progeny tested. Usually about 3 rams are progeny tested for each ram that is selected for use

in each inbred line. Rams are not tested from each line each year as the usual number of test pens is slightly less than the number of lines. The usual procedure is to test several rams from each of as many lines as possible in one year. The choice of the rams to be tested depends on the merit of the rams and the probably need for replacements in the respective lines.

A total of 266 rams were available for 37 lines in the Fall of 1941. Of these 102 rams had progeny tests and 164 did not. Over half of the latter group were yearling rams. Of the 102 rams with progeny tests, 30 were used in inbred lines, 18 were discarded, and 54 were held in reserve. Over half of the rams held in reserve are being kept until the final results from progeny tests become available. Seven of the 164 rams without progeny tests were used in lines, 36 were used in test pens, 98 were culled and 23 were held over for possible testing next year. On the average for each line, one ram was used for breeding, one ram was tested, 2 rams were held in reserve of which one or both had been progeny tested and 3 rams were sold. Of course, the majority of ram lamb offspring from each line were sold before they reached breeding age.

CHANGES IN RECORDS FOR EVALUATION OF MERIT IN RANGE SHEEP

We have felt for some time that some of the observations we have been taking, in order to describe merit in range sheep, were of questionable value. However, we have been slow to discard some of them, because of the slight additional effort involved in taking them, until we could adequately determine their real value. Others have been retained in hopes that a better measure could be found to replace them. With the completion of studies on many of these records we are now certain that some should be discarded. In view of the probable coming shortage of clerical and professional help, and the confusion which too many records may contribute to the problem, it is felt desirable to reduce the observations taken to those which appear clearly essential for describing merit.

We have discontinued the taking of fleece density score, density index, fleece character score, back score, rump score, and leg score. All of these observations have been given only minor, if any, consideration for progeny test and selection purposes in the last few years.

Fleece density score has been taken on all sheep at both weanling and yearling ages. This score is influenced by fleece length, as longer staple fleeces are generally scored as being less dense. It is related to clean weight particularly when considered independently of fleece length. Preliminary results show the heritability of density score to be very low. It is doubtful that fleece density score makes any real contribution to an understanding of fleece value in addition to fleece length, fiber diameter, and clean weight.

Density index has been taken on all sheep at yearling age. Its predictive value at weaning age for the yearling value was too low to warrant

taking it at that age. Errors of sampling and measurement are quite high. It is related to a similar value calculated for the entire fleece. This latter value is very similar to the fleece weight-length ratio using length at the side and the entire clean weight. If fiber diameter and body weight or surface were accounted for then the density index or the weight-length ratio would reflect both variations in numbers of fibers per unit area and variations in fiber length per staple length. Furthermore, with measures of body weight, fiber diameter, clean weight and staple length available the measurement of density index becomes unnecessary. Its double meaning and high error of measurement would indicate that it has doubtful value. It would seem better to base selections entirely on clean weight and fleece length until more concrete specific measures of fiber density or fiber length could be added to give a better understanding of fleece value. It seems that density index or a weight-length ratio as an additional measure to clean weight and staple length would only be confusing.

Fleece character score has been taken on all sheep at weanling and yearling age. Its predictive value of weanling for yearling and its heritability are lowest for all fleece characters under observation. It is related to both clean weight and fleece length, probably because it is affected by these factors. General observations and experience indicate that fleece character score is largely affected by enviornmental factors and therefore has little value for selection or progeny test purposes.

Scores for body type, condition, back, rump and leg have been taken on all sheep at both weaning and yearling age. The purpose of these scores is to evaluate mutton conformation and it is obvious that some measure of body form in addition to body weight is desirable. The fairly high relationship of these scores with each other indicate that they all tend to measure the same thing. Inasmuch as type score is the more general overall value it is logical that it should be the one to be retained.

Condition score has the lowest repeatability from weanling to yearling and a negative daughter-dam relationship, but this situation is probably due to the variability of condition or degree of fatness within individuals from time to time due to environmental effects. Therefore it may have value as an indication of these environmental effects. It will be continued. Back, rump and leg scores have a higher relationship with type score than with body weight or condition score. Where errors in scoring body type are made it seems very probable that the same error would likely be made for each of these scores. Therefore, ratings of individuals or progenies on a basis of type score alone would be little different from ratings in which back, rump and leg scores were also considered.

The Laboratory sheep are sometimes criticised for lack of maximum covering of wool on the belly. This applies to the wool on the underneath portion of a sheep including the covering in the flanks. It is true that practically no attention has been paid to belly wool, except as it may be reflected in fleece weight, as all of our observations are made on the standing sheep. To obtain an idea of the variability of covering of wool on the belly and its importance, all yearling ewes and rams, and all mature rams were scored for this factor this year. This was done by the individual who took the sample for clean yield while the sheep was lying on its side on the sampling table. The following scores were used:

1 - Maximum wool on the belly
2 - Heavy covering of wool on the belly
3 - Moderate amount of wool on the belly
4 - Light covering of wool on the belly
5 - Practically no wool on the belly

EXPLANATIONS OF THE RECORDS TAKEN ARE AS FOLLOWS

Grease fleece weight--Grease (unscoured) fleece weight in pounds, taken on the shearing floor when freed from heavy tags.

Sample for clean yield--Wool samples are taken midway between the scapula and hip joint and between the backbone and belly on the middle of the right side as yearlings. If sheep are sampled as weanlings the same procedure is followed excepting samples are taken from the left side. The side sample areas are cleared with a shearmaster and average approximately 5.2 cm. (2 in.) wide and 11 cm. (4½ in.) long. Samples are placed in air-tight containers, properly identified until they can be scoured.

Fineness sample at side--A lock of wool about the size of a lead pencil is taken for the laboratory determination of fineness and variability. A record is made of any defects such as medullation, hairiness, and kemp. The sample is taken adjacent to the cleared side area (toward backbone).

Fineness sample at thigh--Same determinations made as for side. The sample is taken at the thigh even with the under-line. All fineness samples are placed in coin envelopes, properly identified until cross-sectioning examination can be accomplished.

Length of Staple--Fleece length of staple measured in centimeters, at the middle of the sides of the fleeces, to the nearest 0.2 cm.

Hairiness--Hairiness is scored during docking, at weaning and again as yearlings according to degree or amount of hair present as follows: "S" slightly hairy; "I" Carrying a moderate amount of hair and "E" Extremely hairy over the body and legs.

Face covering score--Wool covering on the face, scored as follows: "1" not covered beyond the poll, "2" covered to the eyes, "3" covered slightly below the eyes, but open faced, "4" covered below the eyes, but not entirely covered and subject to wool blindness, "5" almost or entirely covered and subject to wool blindness. Face scores were illustrated in the 1941 annual report.

Color of face and legs--Color of the hair on the face and legs scored as follows: "1" white with no colored spots or fibers, "2" slightly colored with a few brown or black spots or fibers, "3" a medium degree of color on face or legs, "4" considerable color on face or legs, "5" face or legs completely colored or covered with colored spots.

Horn development--Growth of the horns in degrees of development expressed as "H" fully developed horns in male, "SH" short or partially developed in

RECORDS FOR EVALUATION OF MERIT IN RANGE SHEEP

The records taken at various ages are listed in the following table:

Record	Age at which record is taken						
	Birth (Apr-May)	Docking (Apr-May)	Weaning (August)	Yearling (May-June)	Culling (October)	Rams older than 1 year	Ewes older than year
Grease Fleece Weight				X		X	X
Sample for clean yield				X		X	
Fineness sample at side				X		X	
Length of staple*			X	X		X	
Hairiness	X	X	X	X		X	
Face covering score*			X	X		X	
Color of face and legs	X		X				
Horn development			X	X		X	
Jaw formation	X		X	X		X	
Body weight	X		X	X	X	X	X
Body type score*			X	X		X	
Body condition score*			X	X		X	
Neck folds score*			X	X		X	
Body folds score*			X	X		X	

* Scores, etc., to be taken by each of a committee of three.

Additional records include rating of milking ability of ewe at lambing time, occurrence of defects and abnormalities, reason for culling or cause of death, occurrence of unsoundness, and covering of wool on the belly.

male or female, "LS" long scurs in either sex, "SS" short scurs in either sex, "K" horn knobs in the female, "P" polled with absence of horns, scurs or knobs in either six.

Jaw formation--Proximity of front teeth with dental pad as expressed by the following symbols and measurements: "bo" badly overshot or lower jaw more than 0.5 cm. shorter than upper, "o" overshot--lower jaw from 0.2 to 0.5 cm. shorter than upper, "sl.o" slightly overshot--lower jaw slightly shorter than upper, "ob" front teeth and dental pad approximately meet, "sl.u" slightly undershot--lower jaw slightly longer than upper, "u" undershot--lower jaw 0.2 to 0.5 cm. longer than upper, "bu" badly undershot--lower jaw more than 0.5 cm. longer than upper.

Body weight--Body weight, in pounds, to the nearest $\frac{1}{2}$ lbs. at birth, to the nearest pound at weaning and later, after shearing on yearling and all mature sheep, at culling time on all yearling and mature sheep, and in and out of breeding for all ewes.

Body type score--Trueness to breed appearance and desired mutton conformation, "1" excellent, "2" good, "3" medium, "4" fair, and "5" poor.

Body condition score--Condition or degree of fatness, "1" excellent, "2" good, "3" medium, "4" fair, and "5" poor.

Folds: neck or body--Occurrence of skin folds or wrinkles on the neck or body of the sheep, "1" no folds, "2" very few folds, or small or moderate size, "3" folds of moderate number or size, "4" heavy or large folds of moderate or large number, and "5" completely covered with heavy or large folds.

Numberical Values of Scores Used for Sheep Records

Score	Numerical equivalent	Percent of perfect	General value
1+	0.67	98.3	
1	1.00	95.0	Excellent
1-	1.33	91.7	
2+	1.67	88.3	
2	2.00	85.0	Good
2-	2.33	81.7	
3+	2.67	78.3	
3	3.00	75.0	Medium
3-	3.33	71.7	
4+	3.67	68.3	
4	4.00	65.0	Fair
4-	4.33	61.7	
5+	4.67	58.3	
5	5.00	55.0	Poor
5	5.33	51.7	

Theoretically the scores 6 to 10 should be included, but as scores that low are so infrequent such of them as occur are included in the score "5".

In the terms here used to express general value "excellent" is synonymous with the market term "Choice" "good" means the same as the market term "Good," "medium" means "Medium" on the market, "fair" is synonymous with "Common," and "poor" is synonymous with "Cull."

SCORING OF PROGENY GROUPS

Ratings of progeny groups are made at weaning time. All ram lambs and all ewe lambs are grouped according to sire. Selections at weaning time are made within these sire(or line) groups. These groups are also given group scores on fleece and body characters and an average group score is obtained for all characters.

FACE COVERING IN RAMBOUILLETS

Selection and mating plans have been directed toward removing the wool covering from the faces of Rambouillets to the extent that wool blindness will not be a problem. At weaning in 1941 about 11 percent of the Rambouillet lambs had open faces, 40 percent had partially covered faces and 49 percent had wool covering the entire face. Thus 89 percent were more or less subject to wool blindness.

Where the majority of the flock have covered faces it is likely that the genetic factors producing this character will become fixed in most of the inbred lines in spite of selection for open face unless corrective measures are taken. A breeding plan to introduce and increase the open face character in all lines was approved by the collaborators at their 1941 meeting. This plan consisted of taking a few ewes with covered faces from each of the lines each year to be mated to rams with open faces. These rams would not only have open faces but also would be proven by progeny test for fleece and body character. The offspring from these matings would go back into their respective lines. Attempts will be made to minimize the influence of any one open face ram in any line. This will help to avoid the danger of concentrating any deficiency that any open faced ram might have in any line. It will also minimize the danger of any deficiency becoming associated with open face simply because the ram used to introduce the open face character also carried a particular deficiency which might not be apparent at the time. Different ewes with covered faces may be removed from the lines in successive years. In the 1941 breeding season 5 rams with open faces were mated to 82 ewes with covered faces from the various lines. An additional line selected for open face was initiated in 1941.

SKIN FOLDS IN RAMBOUILLETS

Continued progress is being made in the selection of smooth Rambouillet which are relatively free from skin folds on the neck and body. The proportion of weanling lambs which are smooth or relatively free from folds has increased from 66 percent in 1939 and 1940 to 72 percent in 1941. Particular attention is now being given to the elimination of undesirable folds from the face and the twist region of the thigh.

HORNS IN RAMBOUILLETS

The advisability of developing strains of polled Rambouillet rams was discussed at the 1941 Collaborators' meeting. Two polled lines were initiated in 1941 by mating all ewes in the flock which carry the polled character to two outstanding rams. Selection of polled rams to head each line will be made from the polled male offspring. A total of 45 Rambouillet ewes were found which had depressions instead of horn-knobs and these were divided between the two lines.

OCCURRENCE OF ABNORMAL LAMBS IN RAMBOUILLETS

The occurrence of abnormal lambs has shown but very little increase with increasing degree of inbreeding. Nearly 2 percent of the Rambouillet lambs born in 1942 had black spots, usually on the extremities. Only about 0.33 percent of the lambs showed deformities of various kinds. Two cryptorchid rams or about 0.003 percent were found from 701 rams observed.

CLEAN WOOL YIELD [illegible] STUDIES

There were 840 wool samples and 5-half fleeces scoured from Rambouillet sheep in the special research lines of breeding during the 1942 fiscal year. Percentage clean yield in the small side sample was used in determining the total amount of clean wool in each fleece.

Results were obtained by weighing the grease wool, scouring each sample by the emulsion process (scouring bowls illustrated in 1939 annual report) where a neutral soap and soda ash solution was used. A small revised Wilson-type fleece opener or duster was used in dusting and opening the wool preparatory to scouring (illustrated in 1940 annual report). Clean bone-dry weights were obtained by subjecting all samples to heat treatment in a wool-conditioning oven that drove off all moisture. The wool was weighed on a chain-o-matic balance mounted on the conditioning oven without being exposed to moist air.

METHODS OF MEASURING WOOL QUALITY

A total of 1400 wool samples were analyzed in the animal fiber laboratory for fineness, variability and medullation determinations. Cross-sections were made of each sample and projected upon a receiving screen where they were compared with a known set of standards (35 m.m. film strip) developed at this laboratory (reference No. 14, page 37)for fineness and variability. Medullated wool samples were recorded and expressed in percentage according to a method developed at the NSBL (reference No. 18, page 38).

WOOL CHARACTERS FOR 1941

Reference is made to the following summary of wool characters for 1941 yearling Rambouillet ewes. In general the grease fleece weights were the

Summary of Wool Characters for 1941
Yearling Rambouillet Ewes
(Adjusted to 365 Days Growth)

Fleece Characters	Low	High	Mean
Fleece weight (grease) lbs.	*5.40	14.57	9.34
Fleece weight (clean)			
(Bone dry) lbs.	1.82	5.73	3.45
Commercial-(12% moisture)	2.07	6.51	3.92
Actual for breed**	2.07	6.42	3.86
Clean Yield			
(Bone dry) %	24.64	53.67	36.80
Commercial-(12% moisture)	28.00	60.99	41.82
Actual for breed**	28.57	59.12	41.37
Staple length (cm.)	4.2	8.20	5.99
Staple length (inches)	1 5/8	$3\frac{1}{4}$	$2\frac{1}{4}$
Density index***	1.4	3.20	2.22
Fineness side (microns)	16.00	24.00	18.62
Fineness thigh (microns)	16.00	27.00	21.09
Variability side (std. dev.)	1.5	5.5	2.36
Variability thigh (std. dev.)	1.5	9.5	4.83

* The incidental low producers that appear in the records as yearlings are subject to culling before the breeding season.

** Corrected according to method advanced by Schott, R. G., E. M. Pohle, D. A. Spencer and Glenn W. Brier. Wool Yields in the Small Side-Sample as related to individual whole-fleece yields in four breed-groups of sheep. Journal of Animal Science, Vol.1, No. 2, May, 1942, Pp. 137-144.

*** The density index of wool for fleeces of sheep is the weight in hundredths of a gram of clean, dry wool per cubic centimeter of growing staple. (Discontinued in 1942).

same as in 1940 but the clean yield and clean weights were higher than the previous year. This was probably due to a greater annual precipitation which decreased the amount of dust and dirt. Clean fleece weights, fineness, variability and medullation determinations are used in our selection and culling program as well as in progeny studies. While there is a rather large variation in fleece weight, the mean production indicates that there are not many low producers. These are subject to culling before the breeding season.

COOPERATIVE COMMERCIAL SHRINKAGE RESULTS

The need for reliable information pertaining to wool shrinkage has long been recognized so that clips of wool can be marketed on merit. In view of the need for this type of information on the Bureau's annual wool clip, a cooperative wool scouring test was arranged. This test involved 20 bags (5974 lbs.) of wool, 5 bags for each of four breeds of mature (Yrlg's excluded) ewe fleeces that were graded and scoured by a reputable commercial wool scouring company in the east. These fleeces were a random selection from the respective flocks. The following tabulation of these results are as follows:

Percentage major grade sort for 5 bags of wool for each of 4 breeds of mature ewe fleeces. (Commercially graded at scouring mill).

Breed: / Grade	Rambouillet % of total net weight	Targhee % of total net weight	Columbia % of total net weight	Corriedale % of total net weight
Fine	92			
1/2 Blood	5	87		
3/8 Blood		10	14	30
1/4 Blood			80	61
Low 1/4 Blood			4	7
Low, stained, paint clip & string.	.3	3	2	2
Number of fleeces in test	150	142	129	139
Total net weight of 5 bags. (lbs.)	1622	1462	1457	1433
Percentage shrinkage by breed.(commercial)	57.4	52.7	48.8	47.6

Differences Between Estimates of Shrinkage by Sales Agency Handling Wool Clip for Selling and Those Reported by Commercial Scouring Firm Above.

Lot No.	Grade Quantity and Probable Breed	Shrinkage Estimates placed on wool for selling by Sales Agency	Commercial Scourer's results on 5-bag lots: Test Shrinkages	Difference
		Percent	Percent	Percent
1001	Bright French 15,284 lbs. Rambouillet	63	57.4	5.6
1005	Average French 5,167 lbs. Rambouillet	65	57.4	7.6
1009	Dark French 1,330 lbs. Rambouillet	67	57.4	9.6
1002	Bright ½ Blood 279 lbs. Targhee	58/59	52.7	5.3
1006	Average ½ Blood 827 lbs. Targhee	61	52.7	8.3
1003	Bright 3/8 Blood 1,376 lbs. Corriedale	55/56	48.8	6.2
1007	Average 3/8 Blood 443 lbs. Corriedale	56	48.8	7.2
1004	1/4 Blood 6,549 lbs. Columbia	50	47.6	2.4
1008	Average 1/4 Blood 416 lbs. Columbia	51	47.6	3.4
1010	Low 1/4 Blood 988 lbs. Columbia	48	47.6	0.4

The most important point brought out in the above data when comparing the shrinkage obtained from the 5-bag test lots with the estimated shrinkage on the bulk of the 1941 clip is that a wide range prevailed in nearly every lot of wool and that the estimated shrinkage was always greater than the test shrinkage.

All the lots of Rambouillet wool that were graded as Fine French had an overestimated shrinkage ranging from 5.6 to 9.6%. No doubt Lot No. 1009--Dark French, consisted mostly of buck wool but from scouring data taken each year at this Laboratory on all runs a very small difference is found between

ram and ewe wool shrinkages. There is a discrepancy in each of the other lots of wool between the estimated and actual shrinkage but this overestimation decreases as the wool gets coarser.

The importance of having shrinkage information on clips of wool, as it affects price is best illustrated by the following example: When fine wool sells on the clean basis of $1.00 per clean pound each 1% shrinkage reduces its grease value 1 cent per pound.

1942 CLIP TO BE SECURED BY GRADE

A study of the entire 1942 wool clip is being made. Each fleece was commercially graded as it came from the sheep, and a seperate shrinkage will be obtained for each grade in all breeds for both ewes and rams as far as it is practical for the commercial scouring plant to handle them in this manner. This will yield much needed information on shrinkage by breed and grade for sheep that are operated under strictly range conditions.

CLEAN YIELD RESULTS OF LONG AND SHORTH STAPLE RAMBOUILLET WOOL

One bag (30 fleeces) of wool from a long staple line of Rambouillet ewes was compared with 1 bag (33 fleeces) of shorter staple fleeces for clean yield.

These ewes were born in 1938 and 1939 and were 2 and 3 years old in 1941. Each bag of wool was scoured by the Eavenson and Levering Wool Scouring Co. on a commercial basis. The yearling length and clean yield determinations (1939-40) were made from side samples.

Results show that yearling staple length has considerable affect on amount of clean wool in a fleece and that it also reduces the shrinkage. The results for long and short staple fleeces from yearling ewes and from the same sheep as two and three years of age are tabulated as follows:

	Yearlings (1939-40)			2 and 3 years Old. (1941)		
	Long staple	Short staple	Difference	Long staple	Short staple	Difference
Staple length (corrected to 12 months) cm.	6.29	5.11	+1.18cm.	not	taken.	
Grease fleece weight (corrected to 12 months) lbs.	8.8	8.6	+0.2 lb.	10.8	10.1	+.7 lb.
Clean yield percentage (commercial-12% moisture)	42.4	37.7	+4.8 %	43.5	40.0	+3.5 %
Clean pounds of wool per fleece (commercial-)	3.68	2.98	+0.70lb.	4.71	4.04	+ .67lb.

The longer stpale group as yearlings produced .7 of a pound more clean wool and the same sheep as 2 and 3 year olds produced .67 pounds more clean wool. Considerable difference was noticed in these 2 bins of wool just bevore sacking. The longer staple fleeces in general were more lofty, had a brighter color, noticeably less grease and dirt and made a much more attractive lot of wool. There was a greater spread (4.8%) between clean yield in the yearling fleeces than as 2's and 3's (3.5%). This may be explained in part by the over twelve months growth of wool on the yearlings when they were sheared. While the clean yield percentages differ between years for the groups of fleeces, the side samples gave the same trend in clean yield results as did fleeces from the same sheep at an older age when scoured in bag lots. This served as a check on sampling and scouring methods used in the progeny testing program and points out the importance of length of staple in relation to amount of clean wool.

STAPLE LENGTH IN RELATION TO WOOL PRODUCTION

Staple length is of great importance in Rambouillet wool production. Analysis of production records involving 206 Rambouillet yearling ewes from 1938-41 show them to have an average unadjusted staple length of: 6.59 cm.; 3.52 pounds of clean scoured wool, and 9.79 pounds of grease wool. With each centimeter (3/8 inch) increase in staple length there was an increase of approximately 3/4 pound of grease wool, $\frac{1}{2}$ pound of clean scoured wool and $2\frac{1}{2}$ % in the clean yield.

There is a high relationship between body weight and grease fleece weight and also body weight and scoured fleece weight.

A STUDY TO DETERMINE THE MOST REPRESENTATIVE AREA FOR SAMPLING IN EACH OF THE RAMBOUILLET, TARGHEE, CORRIEDALE AND COLUMBIA BREEDS

This problem was initiated in June, 1941 and involves a study for fineness, variability, clean yield and density index from eight locations in 15 yearling ewes each of 4 breeds. Sample locations for the above wool characteristics were at the top of withers, middle of back, just anterior to the dock, middle of scapula, middle of side, over point of hip and on the belly. The 8-area samples have been scoured and cross-sectioned for fineness, variability and determinations at the Western Sheep Breeding Laboratory, and the 60 individual fleeces were scoured by the Agricultural Marketing Administration in Washington, D. C. The average clean yield, including 12 % moisture by breed is as follows for the entire groups of yearling fleeces:

Breed	Clean Yield Percentage
Rambouillet	39.3 %
Targhee	45.2 %
Columbia	44.5 %
Corriedale	46.5 %

Results from each of the 8 areas are being correlated with the clean yield from each fleece to determine the most representative area for sampling in the 4 breeds.

CLEAN YIELD AND FINENESS DETERMINATIONS IN ZONED AREA SAMPLES

Five 2-year old Rambouillet ewe fleeces were selected for a fleece zoning study. One-half of each fleece was separated into small portions (zones) and the other one-half of the same fleece was scoured intact. This study was initiated to secure basic information relative to the most representative area on the fleece from which to obtain samples for clean yield and fineness determinations. The analysis of these data has not been completed.

This study is being continued in 1942 but with 10 head of yearling Rambouillet ewes.

MOISTURE IN GREASE WOOL

Moisture tests were made at this station on side samples of wool from fleeces that were later shipped to the Agricultural Marketing Administration, Washington, D. C. for scouring. The wool samples were kept in moisture proof containers until July 14, 1941, at which time the moisture and scouring determinations were made in the Laboratory at Dubois. The whole fleeces were shipped to the Agricultural Marketing Administration in regulation wool bags on July 28 but the exact time of moisture and scouring is not known. All samples scoured at this Laboratory were taken during favorable weather conditions just before shearing. The results for moisture content in the grease wool are as follows:

Breed	A. M. A. Laboratory (percent)	W. S. B. L. Laboratory (percent)	Difference (percent)
Rambouillet	10.63	9.53	1.10
Targhee	11.04	8.97	2.07
Corriedale	10.98	8.33	2.65
Columbia	11.28	9.01	2.27
Total	44.93	35.84	8.09
Average	10.98	8.96	2.02

These data show the Rambouillet wool to have the least difference (1.10) in percentage moisture between Washington, D. C. and Dubois, Idaho but the highest in moisture content at Dubois and lowest when tested in Washington. The mean difference for all wool tested was 2.02 percent.

The following shows possible decreases in gross weights of bags of wool from time of shearing until they arrive in the eastern markets:

Bag No.	Gross Weights			
	At time of shearing (June 1)	When shipped (July 28)	When weighed in East	Difference
	Pounds	Pounds	Pounds	Pounds
141	244	232	230	14
142	256	247	243	13
145	184	179	177½	6.5

Much of the difference in weight from time of shearing until the wool arrived on the Atlantic seaboard was no doubt due to the open ends of the bags being soaked in water for convenience on the sacking stand. However, some loss may have occurred due to warmer, drier weather in June and July which dried the wool out somewhat before it was shipped from Dubois.

HAIRY BIRTH COAT IN LAMBS

All lambs were scored for hairiness in the fleece at the time of docking. They were again observed at weaning and as yearlings. Hairiness in fleeces of lambs at weaning were compared with those at docking time and it was generally found that lambs exhibiting hairiness at weaning age had scored as either "moderate" or "extreme" at docking. However, not every lamb scored as hairy at docking was hairy at weaning time. When lambs had a score of "slightly" hairy at docking, seldom did they show this hairiness at weaning age. The types of hairiness displayed at docking age that persist in later months is being studied. Lambs from some rams apparently show a definitely higher percentage of hairiness than do lambs from other rams.

REPRODUCTIVE CAPACITY OF RAMS AS INDICATED BY SEMEN TESTS

Semen tests were attempted on 165 rams preceding the 1941 breeding season. A total of 117 rams gave services from which 426 ejaculates were obtained. These were evaluated for volume, appearance, viscosity, pH, motility, concentration and percent of abnormal spermatozoa. Concentration, motility, and morphology of spermatozoa and the total number of spermatozoa ejaculated in 30 minutes were given prime consideration in predicting fertility.

A total of 108 rams were used in breeding pens of which 41 settled 95 per cent or more of the ewes to which they were bred, 43 settled 85 to 95 percent, 7 settled from 75 to 85 percent and 4 rams showed low fertility, having settled less than 75 percent of the ewes. The remaining 13 rams were used for only part of the breeding period and therefore definite results could not be obtained. It was necessary to use 11 rams in breeding which refused to serve for semen tests and all of these were used for only part of the breeding period. The average percent of ewes preg-

nant, excluding rams used for only part of the period, was 90.3. Percentages of ewes pregnant for the various breeds were 91.9 for Rambouillet inbred lines, 85.4 for Rambouillet test pens, 92.1 for Columbias, 93.0 for Targhees and 94.5 for Corriedales. The lower percentage of pregnancies in the Rambouillet test pens appears to have been partly due to the use of some rams from which semen could not be obtained and from the partial failure of 3 rams which apparently had good semen.

The semen records of the 4 rams with low fertility have been studied carefully. 88RW settled 50% of his ewes and was suspected of low fertility but was used anyway for other reasons. He consistently produced poor semen although it improved slightly with each test and he exhibited a high level of libido. 566RW settled only 7.5 percent of his ewes but had produced what appeared to be excellent semen as judged by volume, concentration, motility, and appearance. The pH of his semen was 8 which is usually associated with lower concentrations. He produced 26 percent abnormal spermatozoa which consisted mostly of morphological abnormalities of the heads. These were not noticeable on the unstained smears which were examined before breeding. The other 2 rams (426RW and 490RW) appeared to have normal semen.

The 7 rams exhibiting reduced fertility (3901R, 142RW, 717E, 460RW, 1227, 3054K and 3104D) showed no serious or consistent defects in their semen. A more detailed analysis now underway may reveal indications which will enable these rams to be detected before breeding.

The possibility of the inheritance of factors for low fertility has been studied although only the relation of rams through family history can be commented on. One important family has been conspicuous for cases of low fertility. The line of rams, 2589R--3576R--88RW and 384RW have all shown low fertility and all have produced poor semen. Ram 566RW, discussed above, is also related to this line. Further studies on the particular defect of the reproductive system which may be involved in this family will be made.

METHODS OF EVALUATING RAM SEMEN

Special semen tests were conducted during the winter on four Rambouillet rams, two with good semen and two with poor semen, to devise improved methods of evaluating semen in order to simplify and speed up the semen tests and to obtain more accurate estimates of a ram's fertility.

Tests were made of the opal blue staining method which differentiates live and dead spermatozoa. The preparation of the opal blue stain was simplified. The optimum pH range was found to be from 6.8 to 7.2. Numerous checks were made to establish the reliability of the opal blue technique. The percents of live, dead, normal and abnormal spermatozoa can be reliably estimated from smears stained with opal blue. An attempt was made to develop a method for determining concentration, percent live and dead, and the abnormal count from one preparation on the haemacytometer, by using a combination of opal blue with the diluting fluid for the spermatozoa concentration counts. Some promising results were obtained but the time required was too long to permit very many ejaculates to be examined in one day.

Identification of abnormal types was checked from routine smears stained with haematoxylin and carbol-fuchsin, opal blue dilutions on the haemacytometer, and slide coverslip preparations of semen with and without stain. A very high agreement was obtained from all preparations except from the smears prepared by the routine method. These, and to a lesser extent, the opal blue smears, exhibited some artifacts of the tail and middle piece, namely, bends and kinks, which were not present in any liquid preparation. Therefore these have been dropped from the classification of abnormalities. One type of bent middle piece was found in live spermatozoa and seems to be related to the adhered type, which also occurs in live spermatozoa, but it cannot be too reliably identified on smears.

Preliminary statistical analysis of the data has brought out some useful results. The pH estimate by Alkacid test paper agrees well with electrometric determinations. A single concentration count with the haemacytometer was not significantly different from 4 counts made by 2 workers. Motility estimates show significant correlations to the percent of live normal spermatozoa as determined from opal blue smears. Correlations were in general higher in poorer semen where accuracy is needed most. The routine staining method was improved by using pH controlled iron haematoxylin and by mass staining methods which allowed the staining of 20 slides at a time with very uniform results.

The results from 71 ejaculates upon 31 rams, where semen was stained by the opal blue method during the regular testing season, agreed in general respects with those made during the special testing, but showed a larger percent of dead spermatozoa. This discrepancy can be largely attributed to inexperience with the technique at that time. The regulations of motility to percent of live spermatozoa were similar to those encountered during the special tests, although the higher motilities were, when considered separately, not significantly correlated to percent of live spermatozoa.

REPRODUCTIVE DEVELOPMENT OF RAM LAMBS

Histological studies are progressing on the tissues from 83 ram lambs and 29 mature rams. Sixteen of the ram lambs were autopsied during the Fall of 1941 to fill in some gaps in the age distribution around the critical ages. Incidentally the meat of all these lambs was sold at market price.

Preliminary observations have been made on testicular sections from 35 lambs ranging in age from 65 to 272 days of age. Morphologically mature spermatozoa were present in some testicles 188 days of age, while others up to 265 days of age were definitely immature. Semen tests have been obtained from ram lambs down to 256 days, and concentrations of spermatozoa above 1,000 million per c.c. have been found in the epididymis and ampulla down to 200 days of age. These are only preliminary observations and not conclusive.

The minute details of spermatogenesis and spermiogenesis are being determined, and methods for statistically evaluating the average state of development of a testicle are being scrutinized.

Analysis of the relation of weight of Cowper's gland to endocrine gland weights, body weight and age have been calculated. All possible direct correlations between weights of Cowper's gland, thyroid, pituitary, testicle, body weight and age were calculated, and all were highly significant. Further studies are being made on these relationships.

WEATHER *

The 1941 precipitation totaled 12.73 inches which was 3 inches less than in 1940 but about 3 inches more than the 15 year average of 9.85 inches. The precipitation for the first 4 months was above normal and this, combined with higher than average mean temperatures, brought on the feed earlier than normal so that it was possible to put ewes with lambs out to graze on April 22. There was an abundance of choice range feed the first part of May but hot drying winds during the latter half of the month dried up the weeds and finer grasses so that lambs had lost their "bloom" by shearing time. A higher than normal precipitation for June which fell mostly during one storm the first week softened the feed for the ewes but did not cause regrowth of the weeds or finer grasses.

Intermittent showers throughout the summer months decreased the hazard of range fires and started some regrowth for fall grazing but made conditions favorable for blow flies, mosquitos and interval parasites.

The mean average temperature for 1941 was about the same as the 15 year average with the winter months slightly warmer and the summer months slightly cooler.

The following is a tabulation of precipitation and mean temperature for the year 1941:

	Precipitation		Mean Temperature	
Month	1941	15 year average	1941	15 year average
January	0.76	0.73	22.4	17.81
February	.32	0.65	26.0	23.06
March	.52	0.57	33.0	30.46
April	1.74	0.77	42.4	42.43
May	0.97	1.00	51.74	53.39
June	1.85	1.14	57.85	60.77
July	0.89	0.76	68.32	69.45
August	1.77	0.91	64.63	66.82
September	0.91	0.81	50.23	54.85
October	0.97	1.05	43.52	45.23
November	.37	0.63	33.12	30.90
December	1.66	0.83	25.65	21.46
Total	12.73	9.85	Average 43.35	43.10

* Records compiled by U. S. Forest Service, Dubois, Idaho.

INCREASING USE OF LABORATORY RAMBOUILLETS

Rams from different Rambouillet lines were used in the 1941-1942 breeding season by the Arizona, Colorado, Idaho, Nevada, Washington and Wyoming agricultural experiment stations, and a ram has now been loaned to the California agricultural experiment station. The object of these loans is to test the Laboratory rams for their ability to improve the various station flocks, and, if improvement is effected, to further test and consolidate these gains by suitable close mating methods. Records of these ram progeny are not available for the 1942 lamb crop.

PUBLICATIONS:

The following papers have been published or mimeographed since the beginning of the Western Sheep Breeding Laboratory in 1937:

1. Measurement of reproductive capacity as an aid in selection of rams of high fertility (A preliminary report). C.E. Terrill, Proceedings of the American Society of Animal Production, 1937, pp 311-316.
2. Artificial insemination of ewes, C.E. Terrill and E.M. Gildow, National Wool Grower, Volume 27, No. 2, December, 1937.
3. Another experiment of long range paternity in sheep, C.E. Terrill and E.M. Gildow, Journal of Heredity, Vol. XXIX, No. 2, February, 1938, pp 77-78.
4. Artificial insemination of ewes with transported semen, E.M. Gildow and C.E. Terrill, Journal of American Veterinary Medical Association, Volume XCIII, N.S. 46, No. 3, September, 1938, pp 157-159.
5. Reproductive capacity of Rambouillet ram lambs as indicated by semen tests, C.E. Terrill, Proceedings of the American Society of Animal Production, 1938, pp 308-310.
6. A preliminary study of the relation between fleece characteristics of weanling and yearling range sheep, W.V. Lambert, J.I. Hardy and R.G. Schott, Proceedings of the American Society of Animal Production, 1938, pp 298-303.
7. Reproduction in range sheep, C.E. Terrill and John A. Stoehr, Proceedings of the American Society of Animal Production, 1939, pp 369-375.
8. Selection of range Rambouillet ewes, C.E. Terrill, Proceedings of the American Society of Animal Production, 1939, pp 333-340.
9. Comparison of the accuracy of two methods of estimating fineness of wool fibers, Ralph W. Phillips, R.G. Schott, J.I. Hardy and H.W. Wolf, Journal of Agricultural Research, Vol. 60, No. 5, March 1, 1940, pp 343-350
10. A summary of three years' work in the transportation of ram semen for artificial insemination, Ralph W. Phillips, R.G. Schott, E.M. Gildow and C.E. Terrill, to be published in the Proceedings of the Second National Meeting of Veterinary Surgeons of Italy, 1940.
11. The Western Sheep Breeding Laboratory and U.S. Sheep Experiment Station, Julius E. Nordby, published in Extension Animal Husbandman, September, 1940.
12. Genetics and range sheep improvement, Julius E. Nordby, Scientific Monthly, October, 1940, Vol. LI, pp 310-320.
13. Some factors affecting the progeny testing of rams, Ralph W. Phillips, R.G. Schott, W.V. Lambert and G.W. Brier, U.S.D.A. Circular No. 580, October, 1940, 17 pp.
14. The application of a rapid comparator method for determining fineness and variability in wool, Elroy M. Pohle, Proceedings of the American Society of Animal Production, 1940, pp 161-168.
15. Comparison of ram semen collection obtained by three different methods for artificial insemination, Clair E. Terrill, Proceedings of the American Society of Animal Production, 1940, pp 201-207.
16. Growth in Corriedale and Rambouillet sheep under range conditions, Ralph W. Phillips, John A. Stoehr and G.W. Brier, Proceedings of the American Society of Animal Production, 1940, pp 173-181.
17. Sheep improvement for range production, Julius E. Nordby, Idaho Forester, Vol. XXIII, 1941.

18. A rapid method for expressing medullation in wool, Elroy M. Pohle, Animal Husbandry Division No. 41, May, 1941, 6 pp.
19. Columbia sheep and their place in range sheep production, Damon A. Spencer and John A. Stoehr, Animal Husbandry Division No. 42, October, 1941, 2 pp.
20. Targhee sheep and their place in range sheep production, Damon A. Spencer and John A. Stoehr, Animal Husbandry Division No. 43, October, 1941, 2 pp.
21. Face covering in range sheep, Clair E. Terrill, Animal Husbandry Division No. 49, November, 1941, 9 pp.
22. Wool yield determinations in which small samples are compared with whole fleeces, Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer and Glenn W. Brier, Animal Husbandry Division No. 50, January, 1942, 6 pp.
23. Wool yields in the small side sample as related to individual whole-fleece yields in four breed-groups of sheep, Ralph G. Schott, Elroy M. Pohle, Damon A. Spencer and Glenn W. Brier, Journal of Animal Science, Vol. 1, No. 2, May 1942, pp 137-144.
24. The importance of body weight in selection of range ewes, Clair E. Terrill and John A. Stoehr, to appear in Journal of Animal Science, Vol. 1, No. 3, August, 1942.
25. Relationship between weanling and yearling fleece characters in range sheep, Elroy M. Pohle, to appear in Journal of Animal Science, Vol. 1, No. 3, August, 1942.
26. Staple length in relation to wool production, Elroy M. Pohle and Henry R. Koller, in process of publication.

U. S. SHEEP EXPERIMENT STATION

It is not possible to make a very specific segregation between the reports of the Western Sheep Breeding Laboratory and the U. S. Sheep Experiment Station. A number of the projects and surely many of the activities are overlapping. In general, many if not most of these are found in the former in order to make it complete, and an effort has been made to avoid duplication of them in the latter.

ANNUAL REPORT
U. S. Sheep Experiment Station
June 30, 1942

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PROJECT SUMMARY

LINES IN COLUMBIAS, TARGHEES AND CORRIEDALES

Inbreeding has increased more rapidly in Columbias, Targhees and Corriedales than in Rambouillets because of a higher reproductive rate and because of the higher relationship in foundation animals. The average inbreeding coefficients for live lambs born in 1942 were 5.63, 7.80 and 10.73 percent respectively (page 42).

SELECTION FOR BODY WEIGHT IN RANGE SHEEP

The average increase in pounds of lamb weaned per ewe year with each pound increase of fall yearling weight of the dams was 0.49, 0.48 and 0.63 for Columbias, Corriedales and Rambouillets respectively. The fleece weight was a little heavier for the larger ewes, although not materially heavier probably because of the heavier lamb production of the larger ewes (page 42).

SUPPLEMENTAL GRAIN FOR WINTERING EWE LAMBS

The grain-fed group had a higher average body-weight and slightly heavier fleece weight than the group receiving hay alone. Lamb production was generally in favor of the grain-fed ewes (page 44).

SHEEP MANAGEMENT INVESTIGATIONS

Where proper management alone permitted increases in grazing capacity of 30 to 40 percent in 4 years, sagebrush removal has permitted doubling or even trebling the grazing capacity in 3 years (page 45).

PHOSPHORUS INVESTIGATIONS

Phosphorus intake from range feed or alfalfa hay may be low during the winter season. However, there is no definite evidence of actual phosphorus deficiency at any time during the year. Blood phosphorus appeared to decrease when ewes were increasing in condition and increase as ewes lost weight (page 45).

OCCURRENCE OF BROWN COLOR

A method for improving the accuracy of this score has been devised. The percentage of lambs born with color decreased from 1939 to 1941 (page 48).

ABNORMAL LAMBS

Defective lambs appear to be small in number. Black spotting, which is recognized as a color defect, is most pronounced of all defects. (page 48).

WOOL CHARACTERS FOR THE TARGHEE, CORRIEDALE AND COLUMBIA

The mean clean wool yield for all these breeds varies from 4.27 in the Targhees to 4.82 pounds in the Columbia. It is notable that the half blood Targhee wool has a clean yield of 44.45 percent as compared with 48.64 and 45.55 percent respectively for the Corriedale and Columbia wool which is in general 3/8 to 1/4 blood. The mean adjusted fleece length of the Targhees is about 3 inches, the Columbias about 3 1/3 and Corriedales about 3 1/2 inches. The greatest variability in the side and thigh wool samples is in Columbias and then in order the Corriedale and Targhee (page 49).

Summary of Ewes in Columbia Breeding Pens
1941-42 Breeding Season

Pen No.	Ram No.	Type ewes	No. ewes	Type score	Yearling body weight (lbs.)	Yearling adj. fleece weight (lbs.)	Yearling adj. fleece length (cms.)	Inbreeding coefficient Dams %	Inbreeding coefficient Offspring %	Age of ewes at breeding (years)
1	3172K	K	20	1.67	105.90	11.16	8.76	13.38	15.85	3.65
		K2	13	1.97	103.15	11.58	8.70	0.49	2.61	2.69
2	2694K	K	23	1.96	104.49	11.27	8.85	6.26	23.30	2.52
		K2	3	2.11	111.33	12.45	8.73	0	7.10	2.00
		A	10	2.40	85.30	9.37	8.38	0	0	4.30
3	2726K	K	21	2.14	98.00	10.14	8.29	4.73	15.14	3.29
		K2	23	1.96	104.78	11.36	8.70	1.50	6.34	2.00
4	3259K	K	24	2.00	103.54	11.12	8.37	8.67	14.12	2.54
		K2	21	2.00	102.62	11.55	8.50	0.44	0.78	2.05
5	3134K	K	22	1.99	103.86	10.81	8.44	3.34	13.59	2.73
		K2	18	1.98	104.11	11.30	8.87	0.34	3.86	2.33
6	2895K	K	22	1.97	106.86	10.75	7.90	7.09	22.05	2.36
		K2	24	1.92	102.63	10.96	8.57	0.80	4.11	1.96
7.	3773K	K	15	2.15	102.53	10.72	8.02	10.43	11.83	3.20
8	3054K	K	20	1.98	104.80	10.29	8.28	3.15	9.35	2.70
		K2	24	2.13	94.46	11.03	8.87	0.98	3.25	2.17
		A	16	2.39	81.81	7.90	8.04	0	0	1.94
9	3427K	K	19	2.04	102.89	10.10	7.97	4.16	4.96	2.42
10	3104K	K	20	1.88	101.10	10.47	8.15	5.04	4.68	3.55
11	3477K	K1B	12	2.03	90.58	10.17	8.82	0	0.40	4.83
		K1L	9	2.15	89.55	11.20	9.01	0	2.22	2.22
		LxR	4	2.00	102.50	10.37	8.95	0	0.30	4.75
12	3823K-	K1B	15	2.33	92.53	10.41	9.13	0.11	1.10	4.93
		K1L	9	1.93	106.00	10.50	8.07	0	5.17	2.33
		LxR	3	2.00	94.00	10.93	8.43	0	0.53	4.33
13	3264K	K1B	13	2.13	93.54	10.75	9.20	0	0.97	5.15
		K1L	8	1.88	105.63	11.39	7.96	0	3.95	2.50
		LxR	5	2.20	98.20	10.54	9.54	0	0	6.00
14	3387K	K1B	14	2.07	94.14	10.90	9.27	0	0.51	4.86
		K1L	8	1.71	110.13	10.76	8.18	0	2.86	2.50
		LxR	4	2.75	92.25	10.52	9.78	0	0	6.00
15	3490K	K1B	16	1.94	96.75	10.35	9.02	0	0.58	4.50
		K1L	7	1.95	101.00	10.67	8.66	0	0.79	2.14
		LxR	3	2.22	99.33	12.30	9.77	0	0	5.00
16	3335K	K1B	15	2.27	89.67	10.34	9.13	0	0.52	4.53
		K1L	7	1.95	98.72	10.48	9.64	0	4.90	2.14
		LxR	4	2.75	90.50	10.47	10.00	0	0	6.00
17	3418K	K1B	15	2.13	94.67	10.49	9.21	0	0.51	4.73
		K1L	6	2.17	100.83	10.87	8.85	0	3.05	2.50
		A	1	2.67	86.00	9.02	8.50	0	0	4.00
		LxR	3	3.00	86.67	11.15	9.00	0	0	6.00
18	3043K	K1B	15	2.22	92.47	10.25	8.82	0	0.39	4.53
		K1L	7	2.00	102.57	10.61	8.27	0	3.37	2.29
		LxR	4	2.25	91.00	10.68	8.38	0	0	6.00
TOTALS		K	206	1.97	103.45	10.70	8.32	6.54	13.82	2.87
		K2	126	1.99	101.94	11.29	8.70	0.78	3.68	2.15
		A	27	2.41	83.26	8.49	8.18	0	0	2.89
		K1B	115	2.14	93.12	10.46	9.09	0.01	0.62	4.75
		K1L	61	1.96	103.23	10.32	8.56	0	3.32	2.33
		LxR	30	2.39	94.53	10.94	9.26	0	0.09	5.57
GRAND TOTAL			565	2.05	99.55	10.70	8.63	2.56	6.35	3.18

Summary of Ewes in Targhee Breeding Pens 1941-42 Breeding Season.

Pen No.	Ram No.	Type ewes	No. Ewes	Type Score	Yearling body weight (lbs.)	Yearling adj. fleece weight (lbs.)	Yearling adj. fleece length (cms.)	Inbreeding coefficient Dams %	Inbreeding coefficient Offspr. %	Age of ewes at breeding (years)
1	1700T	T	26	1.99	95.12	10.60	7.17	4.22	14.25	2.65
		A	3	2.67	80.67	8.74	7.90	0	0	2.67
		B	8	3.00	81.00	11.83	9.25	0	0	8.00
2	1225T	T	24	1.90	93.17	10.20	7.59	3.83	14.79	3.58
		A	3	2.56	88.33	9.38	8.53	0	0	3.00
		B	2	3.00	79.00	11.29	9.60	0	0	7.50
3	1518T	T	24	2.07	89.50	10.15	7.20	3.95	11.35	3.21
		A	4	2.83	80.00	9.49	9.68	0	0	2.75
		B	1	3.00	88.00	8.89	9.40	0	0	8.00
4	1807T	T	24	2.19	92.58	10.67	7.72	0	0	2.21
		A	4	2.58	83.00	9.13	8.65	0	0	2.25
		B	1	3.00	66.00	11.67	9.70	0	0	8.00
5	1550T	T	22	2.06	88.86	9.77	7.14	5.61	12.68	3.09
		A	5	2.53	87.60	9.36	8.42	0	0	2.60
		B	2	2.50	91.50	12.73	10.05	0	0	7.50
6	1759T	T	23	2.29	96.09	10.66	8.00	0	4.45	2.04
		A	3	2.89	79.67	9.16	8.47	0	0	2.67
		B	3	3.00	81.33	11.20	10.67	0	0	7.67
7	1230T	T	20	2.12	89.55	9.72	7.17	5.44	17.38	2.75
		A	3	2.33	81.33	8.58	9.10	0	0	1.67
		B	2	1.50	88.00	12.82	9.85	0	0	7.00
		LxR	1	2.00	90.00	8.98	10.50	0	0	6.00
8	1986T	T	20	2.10	94.35	10.22	7.14	6.00	10.90	3.85
9	1863T	T	23	2.09	89.83	9.03	7.24	1.90	2.87	1.26
10	1783T	T	23	2.03	94.00	9.28	7.13	1.57	2.24	1.22
TOTALS		T	229	2.08	92.36	10.04	7.35	3.18	9.01	2.57
		A	25	2.63	83.20	9.16	8.70	0	0	2.52
		B	13	2.69	82.85	11.65	9.89	0	0	7.62
		LxR	1	2.00	90.00	8.98	10.50	0	0	6.00
GRAND TOTAL			268	2.16	91.03	10.03	7.61	2.72	7.70	2.82

Summary of Ewes in Corriedale Breeding Pens 1941-42 Breeding Season.

1	3720A	A	27	2.32	86.37	10.22	8.87	3.17	12.75	2.37
2	3130A	A	27	2.14	94.81	9.87	9.40	1.56	14.34	3.07
3	3407A	A	25	2.55	84.48	10.31	9.11	5.11	9.35	2.84
4	3383A	A	26	2.38	86.08	10.57	8.90	2.82	9.85	3.00
5	3266A	A	23	2.38	84.61	9.23	8.42	1.54	6.10	2.91
TOTAL		A	128	2.35	87.41	10.06	8.96	2.85	10.64	2.84

PROGRESS IN LINES OF COLUMBIA, TARGHEE AND CORRIEDALE SHEEP

In the fall of 1941 matings were made in 10 Columbia lines, 8 Columbia test pens, 8 Targhee lines, 2 Targhee test pens, and 5 Corriedale lines. The total numbers of ewes going into breeding were 565, 268, and 128 for the Columbia, Targhee, and Corriedale breeds respectively.

Inbreeding has increased more quickly in these breeds than in the Rambouillets partly because of their higher reproductive rates and because of the higher relationships among the foundation animals. The average inbreeding coefficients of ewes going into breeding in 1941 were 2.56, 2.72, and 2.85 percent respectively for the Columbia, Targhee, and Corriedale breeds. The average inbreeding coefficients for live lambs born in 1942 were 5.63, 7.80, and 10.73 percent respectively for the Columbia, Targhee and Corriedale breeds.

Efforts are being made to select outstanding sires for fleece and body characters rather than to increase the rate of inbreeding. It is hoped that the number of Targhee test pens can be increased. The ewes available for Corriedale breeding were too few to permit test pens. In general rams are selected on their own records and tested in the lines for the Targhee and Corriedale breeds.

SELECTION FOR BODY WEIGHT IN RANCH SHEEP

Results reported last year showed that body weight of yearling ewes was related to lifetime lamb production. Ewes which were heavier in the fall as yearlings, on the average, weaned more pounds of lamb per ewe year during their lifetime. Further studies have been completed on these data. The average increase in pounds of lamb weaned per ewe year with each pound increase of fall yearling weight of the mothers was 0.49, 0.48, and 0.63 for the Columbias, Corriedales, and Rambouillets respectively.

The advantages in favor of the heavier ewes was due both to a higher percentage of lambs weaned and to heavier weaning weights. In general the percent of lambs weaned accounted for a much greater proportion of the differences in lamb production among body weight groups than did weaning weight. Thus it appears that within breeds the advantage in lamb production of the heavier ewes was due more to higher reproductive ability than to factors which contributed more to weaning weight such as milk supply and growth rate.

Factors which show more specific differences in reproductive ability among the body weight groups are shown in the table on the next page. In general, the heavier groups have definite advantages over the lighter groups in the number of ewes lambing per 100 ewe years and in the number of lambs born per 100 ewes lambing. With the exception of the Columbias the heavier groups also produced a higher proportion of live lambs. The failure of the heavy group of Columbia ewes to exceed definitely the middle group in lamb production might be attributed to range feed conditions which were inadequate to produce maximum production with sheep of that size.

Factors contributing to lamb production within groups of range ewes divided on the basis of fall yearling body weight

Breed	Grouping of ewes on basis of fall yearling weight	No. Ewe Years*	No. ewes lambing per 100 ewe years	No. lambs born per 100 ewes lambing	No. Live lambs per 100 lambs born	No. lambs weaned per 100 live lambs born
Columbia	114 lbs. and lower	196	90	120	93	82
		464	96	120	93	90
	115-130 lbs.	196	93	127	89	86
	131 lbs. and higher					
Corriedale	100 lbs. and lower	220	95	110	93	93
		516	96	114	92	92
	101-115 lbs.	228	97	119	97	93
	116 lbs. and higher					
Rambouillet	105 lbs. and lower	320	90	112	91	82
		588	93	117	92	81
	106-118 lbs.	304	96	126	95	81
	119 lbs. and higher					

(*) First 4 lambing years of each ewe.

There were no definite trends among the groups in the proportion of lambs weaned of live lambs born. Thus, the heavier groups which had more lambs also had the additional milking and mothering ability necessary to carry the larger number of lambs to weaning. The number of lambs born or twinning ability, appeared to be more than twice as important as the number of ewes lambing per ewe year while loss of lambs at birth and from birth to weaning were least important in bringing about differences between the light and heavy groups of ewes in percent of lambs weaned.

There was an inverse relationship between average lifetime body weight and pounds of lamb weaned per ewe year were considered independently of the fall yearling weight. Thus ewes heavier as yearlings have their mature weights decreased because of their higher lamb production while the lighter yearling ewes have their mature weights increased because of their lower lamb production. This emphasizes the desirability of basing selection on body weights taken prior to the first breeding.

There was a slight advantage in the average 2-5 year fleece weight in favor of ewes which had been heavier as yearlings. The differences between the lightest group and heaviest group was 0.7, 0.4, and 0.2 pound of wool per ewe year for the Columbia, Corriedale, and Rambouillet, respectively. There were practically no differences among the groups in average 2-5 year fleece lengths.

The tendency for the fleece weights to be relatively the same in the three body weight groups was due in part to the greater lamb production of the heavier ewes. This is shown by an inverse relationship between average lifetime fleece weight and pounds of lamb weaned per ewe year.

Lamb production per unit of body weight was greater for the heavier ewes. However, the lighter ewes produced more wool per unit of body weight.

SUPPLEMENTAL GRAIN FOR WINTERING EWE LAMBS

In order to determine the influence on subsequent fleece weights, body weights and lamb production of feeding a small amount of grain to ewe lambs being wintered on alfalfa hay, 56 Targhee, 44 Columbia, 70 Corriedale, and 212 Rambouillet ewe lambs were divided as evenly as possible on the basis of their weanling weight, weanling fleece length, and breeding into two groups. One group received approximately 1/4 pound of whole oats per head daily in addition to alfalfa hay while the other received only alfalfa hay. The alfalfa hay was of only fair quality. These two groups of ewe lambs were weighed individually on January 10, 1941 at the end of the grain feeding period. At the beginning of the period the group fed grain averaged 0.57 pound heavier than the group not fed grain. At the end of the 92 day period, the group receiving grain averaged 97.27 pounds in body weight which was 13.51 pounds heavier than the average for the group receiving no grain. At scoring and shearing time about the first of June, 1941, the grain fed group averaged 91.78 pounds in sheared body weight while the other group averaged 6.01 pounds less. The grain fed group found it more difficult to adjust themselves to the off-grain period than did the group that did not receive grain.

The grained group as a whole had a slight advantage in unscoured and scoured fleece weight of .23 and .09 of a pound respectively, with the Rambouillets and Corriedales showing an increase over those of the same breed in the group without grain while the Targhees that received no grain had slightly heavier unscoured and scoured fleece weights than those that received grain. The Columbia ewes that were fed grain had slightly lower unscoured fleece weights and slightly heavier scoured fleece weights than the Columbias which received no grain. There was very little difference between the two groups in staple length, the Columbias and Corriedales of the grained group having an advantage of .13 to .14 centimeters respectively while the Targhees and Rambouillets of the group without grain had an advantage of .34 and .07 centimeters respectively.

At culling in October, 1941, the grain fed group averaged 115.83 pounds in body weight or 4.78 pounds heavier than the group without grain. At lambing in the spring of 1942, 24 Corriedales, 16 Columbias, 22 Targhees, and 97 Rambouillets remained of the group fed grain as ewe lambs after 27 were culled and 1 dead or missing, while 23 Corriedales, 18 Columbias, 19 Targhees, and 90 Rambouillets remained of the group without grain, after 35 had been culled and 2 were dead or missing. The grained group as a whole had 94.34 percent of ewes pregnant, 98.74 percent lambs born and 89.31 percent lambs born alive based on ewes bred as compared with 89.26, 95.29, and 87.33 respectively for the group that did not receive grain. This relationship held for all breeds except the Corriedale in which 87.5 percent of the ewes in the grained group were pregnant with 91.67 percent of lambs born and 79.17 percent of lambs born alive as compared with 95.65, 104.35, and 100.00 respectively for the group without grain. The birth weight of lambs were 9.20 and 8.87 pounds respectively for the lambs from the groups with and without grain. The ewes in the grained group produced an average of 8.78

pounds of unscoured wool and averaged 103.56 pounds in body weight while ewes from the group without grain produced 8.57 pounds on the average of unscoured wool and averaged 100.85 pounds in body weight.

Additional information as to the lifetime value of the grain fed to these ewes as ewe lambs will be available later.

SHEEP MANAGEMENT INVESTIGATIONS

Sagebrush removal, using controlled burning and followed by proper management, is the most promising method so far tested for improving depleted sagebrush-grass range lands. Where proper management alone permitted increases in grazing capacity of 30 or 40 percent in 4 years, sagebrush removal has permitted doubling or even trebling the grazing capacity in 3 years. Where necessary, sagebrush removing may be profitably followed by reseeding. Sagebrush removal, coupled with rotation management and proper stocking offers an outstanding method of increasing production of lamb and wool on sagebrush lands.

PHOSPHORUS INVESTIGATIONS WITH RANGE SHEEP

A study on the seasonal variation in the blood phosphorus level of range ewes in cooperation with the Idaho Experiment Station, which has been underway for 4 years, is nearing completion. Blood samples have been collected from a group of about 40 Columbia ewes at 3 to 7 different times during each year. Analyses of the phosphorus content of the blood have been made by the Idaho Station.

The results are summarized in Table 1. Marked individual variations in blood phosphorus level were noted. However, seasonal trends were fairly definite. Blood phosphorus levels were fairly low in September and November followed by an increase in December and January. The hightest average blood phosphorus content was found on the winter range in the cooler part of January followed by a decrease on the feed lot to the lowest level at lambing time. A high blood phosphorus content was found again on the spring range in June. Significant variations between years at one season were found for the winter range, at the end of the winter breeding period, at lambing time, and in November on the fall range. These would appear to be the seasons when the factors which affect blood phosphorus are most variable.

Blood phosphorus levels of 3.5 mg. or below which might be considered as deficient were found at all seasons except on the winter range. The percentages of ewes having blood phosphorus levels of 3.5 mg. or below for the various seasons were 5.3 for the fall range, 2.5 for the feed lot, 20.0 at lambing, 2.7 for the spring range, and 10.0 for the summer range.

In the years when cottonseed cake was fed on the winter range for about a 3 week period at the rate of one third pound per head per day the average inorganic phosphorus content of the blood was 6.08 mg. per 100 ml. plasma as compared with 5.61 mg. when no supplement was fed. Likewise in the winter feeding period when oats were fed at the rate of one half pound per head per day the phosphorus content of the blood was 4.88 mg. as compared with 4.26 mg. when no oats were fed.

Table 1. Seasonal Variations in Blood Phosphorus Levels of Range Ewes

Year	Dates	Fall Range Nov. 16 (mg.%)*	Winter Range Dec. 14-18 (mg.%)	Winter Range Jan. 6 (mg.%)	Winter Range Jan. 17-24 (mg.%)	Alfalfa Hay Feed Lot Feb. 19-28 (mg.%)	Alfalfa Hay Feed Lot Mar. 27 Apr. 3 (mg.%)	Lambing April 19-21 (mg.%)	Spring Range June 10-11 (mg.%)	Summer Range September 3-13 (mg.%)
1938-39	Range	3.2-6.0			4.1-6.5	4.0-6.6				
	Mean	4.93			5.14	5.08				
1939-40	Range	2.6-5.5	3.4-6.2		4.6-8.2		3.3-5.2	2.3-5.3	3.8-7.2	3.1-5.9
	Mean	4.10	5.16		6.06		4.26	3.81**	5.39	4.57
1940-41	Range		4.0-8.0	4.2-7.3	4.1-9.9			2.5-8.3	3.2-8.2	3.2-7.1
	Mean		5.11	5.30	6.16**			4.31**	5.47	4.60
1941-42	Range		4.0-6.7		4.3-8.5	3.0-7.3	3.6-8.0	3.1-7.3		
	Mean		5.20		5.99**	4.83	4.88	5.09**		
1938-42	Mean	4.52	5.16	5.30	5.85	4.96	4.56	4.39	5.43	4.59

* mg. inorganic phosphorus per 100 ml. blood plasma

** after supplemental feeding of cottonseed cake or oats

Blood samples were collected at lambing time when about half of the ewes had lambed. Blood phosphorus levels were definitely higher for ewes that had not yet lambed than for ewes that had already lambed. Ewes suckling twin lambs had lower blood phosphorus content than ewes suckling single lambs.

There is an indication that blood phosphorus tends to decrease with age.

Table 2 was made up from all ewes bled from 1938 to 1941 from which a determination had been made for each bleeding.

Table 2. Variation in Blood Phosphorus Content with Age.

Age of ewe	No. of ewes	Mg. inorganic phosphorus per 100 ml. plasma
2	23	5.17
3	21	5.17
4	12	5.03
5	14	4.68
6	12	4.87
7	6	5.23
8	2	4.14

The blood phosphorus content at the end of breeding in the middle of December was found to be definitely higher (5.18 mg.) for those ewes which later had single lambs than for those ewes which later had twin lambs (4.85 mg.). This difference was apparent within age groups. Two year old ewes were excluded from this comparison because practically all of them have single lambs. It was also found that ewes which lost weight during breeding had a slightly higher blood phosphorus content than those which gained in weight during breeding.

Excepting for low blood phosphorus levels, no definite evidence of phosphorus deficiency was found at any time during the year. The higher blood phosphorus levels found after feeding cottonseed cake or oats on the winter range and winter feed lot indicate that the phosphorus intake from range feed or alfalfa hay may be low at these times. The relation of ovulation rate and gain or loss in weight to blood phosphorus may help explain the high blood phosphorus contents obtained on the winter range where phosphorus intake would be expected to be low. There is an apparent parallel between the changes in blood phosphorus levels and observed gain or loss in condition or weight throughout the year. The ewes invariably lost weight on the winter range where blood phosphorus was highest and they steadily gained weight during winter feeding of alfalfa hay where the blood phosphorus decreased. Loss in weight usually takes place on the spring range while they are suckling lambs and where the blood phosphorus levels were high. In the fall after weaning, ewes gained in weight and the blood phosphorus again decreased. It is believed that more intensive studies on the factors affecting blood phosphorus are needed before it can be adequately used as an indicator of phosphorus intake from range feed.

OCCURRENCE OF BROWN COLOR IN RANGE SHEEP

Continued progress has been made in the elimination of brown color from the face and legs of the various breeds. The percentages of weanling lambs with brown color for the 3 year period are listed as follows:

	Corriedales	Targhees	Columbias
1939	37	25	17
1940	30	25	14
1941	28	11	12

It is difficult to accurately score color particularly where only traces of color are present. A comparison of scores for color, at birth and at weaning, has been made over a 2 year period on about 1400 lambs. This study has shown that about 11 percent of the lambs scored for color were scored as having color at birth but not at weaning and about 11 percent as having color at weaning but not at birth. Scores at birth were largely made by one individual and weaning scores were made by a different individual. It is notable that the errors were practically equal for the 2 individuals scoring the same sheep at different ages. A method has been devised for the further reduction of these errors. This consists of rechecking color scores on all individuals at weaning time where the weaning score does not agree with the score made at birth. Thus, a final weaning score may be recorded which should be more accurate than one independent score.

OCCURRENCE OF ABNORMAL LAMBS IN RANGE SHEEP

A continued decrease was noted in the proportion of abnormal lambs from Corriedale, Columbia and Targhee sheep in 1942. A total of 23 abnormal lambs were observed from 1117 lambs dropped or 2.16 percent as compared with 2.4 and 2.5 percent in 1941 and 1940 respectively. Most of the abnormalitities consisted of black spots. Only 0.37 percent of lambs showed deformities of various kinds. One cryptorchid lamb was observed from 204 Columbia ram lambs.

WOOL CHARACTERS FOR THE TARGHEE, CORRIEDALE AND COLUMBIA BREEDS OF SHEEP FOR 1941

Reference is made to the 1941 summary of wool characters for Targhee, Corriedale and Columbia ewes. In general the grease fleece weights were the same as in 1940 but the clean yield and clean fleece weights were higher than the previous year. This was probably due to a greater annual precipitation which decreased the amount of dust and dirt. Clean fleece weights, fineness, variability and medullation determinations are used in the selection and culling programs as well as in the progeny studies. While there is a rather large variation in fleece weight, the mean production indicates that there are not many low producers. These are subject to culling before the breeding season. The fineness readings in microns may be converted to commercial grade for wool tops according to the accepted spinning count standards. However, the commercial grading of the wool shows the fleeces to be coarser than do the laboratory determinations for fineness in microns. This may be partially observed by comparing fineness readings in microns from the wool character chart and the commercial grading records on pages 25 and 27.

In general the Targhee wool has shown great improvement in uniformity of length and fineness. It seems to be well adapted to Intermountain range conditions such as prevail around Dubois, Idaho.

CLEAN WOOL YIELD AND FINENESS DETERMINATIONS

There were 1568 wool samples and 5 half-fleeces scoured from the test Rambouillet, Targhee, Corriedale and Columbia sheep during the 1942 fiscal year. Percentage clean yield in the small sample was used in determining the total amount of clean wool in each fleece. A total of 2376 wool samples were cross-sectioned for fineness, variability and medullation determinations.

METHODS OF MEASURING WOOL QUALITY. Refer to page 25.

COOPERATIVE COMMERCIAL SHRINKAGE RESULTS AND THE 1942 CLIP. Refer to page 27.

STAPLE LENGTH IN RELATION TO WOOL PRODUCTION

Staple length is of great importance in wool production. Analysis of production records involving 281 Targhee, 251 Columbia and 245 Corriedale yearling ewes from 1938-1941 show them to have the following unadjusted fleece and body weight averages:

	Staple Lgth. (cms.)	Grease Wool (lbs.)	Clean Wool (lbs.)	Body Weight (lbs.)
Targhee	8.53	11.12	4.39	90.5
Columbia	9.90	11.95	5.31	101.3
Corriedale	10.30	10.64	4.62	82.9

With each centimeter (3/8 inch) increase in staple length there was the following increase for the various characters:

Summary of Wool Characters for 1941 Yearling Ewes
(Adjusted to 365 days growth)

Fleece Characters	Targhee			Corriedale			Columbia		
	Low	High	Mean	Low	High	Mean	Low	High	Mean
Fleece weight, grease, lbs.	*6.55	15.92	9.60	*5.06	13.99	9.53	*5.81	16.13	10.59
Fleece weight, clean									
Bone dry, lbs.	2.14	5.53	3.91	2.41	6.57	4.25	2.65	7.74	4.67
Commercial (12% moisture)	2.43	6.28	4.44	2.74	7.47	4.83	3.01	8.80	5.31
Actual for breed**	2.35	6.06	4.27	2.58	7.03	4.64	2.75	8.03	4.82
Clean yield, %									
Bone dry	31.53	57.46	40.82	31.97	68.48	45.59	31.13	53.07	43.93
Commercial (12% moisture)	35.83	65.30	46.39	36.33	77.82	51.69	35.38	60.31	49.92
Actual for breed **	34.68	61.96	44.45	34.42	72.83	48.64	32.08	55.17	45.55
Staple length, (cm.)	5.50	9.50	7.62	7.00	12.60	8.98	6.10	10.70	8.57
Staple length, (inches)	2.13	3.75	3.00	2.75	5.00	3.50	2.38	4.25	3.38
Density index ***	1.40	3.20	2.00	1.30	2.60	1.87	1.40	2.80	1.94
Fineness, side, microns	18.00	27.00	19.91	17.00	27.00	21.38	19.00	30.00	24.08
Fineness, thigh, microns	19.00	28.00	23.00	20.00	32.00	24.92	23.00	43.00	27.94
Variability, side (std.dev.)	1.50	6.00	3.20	1.50	7.00	3.88	3.00	8.00	5.45
Variability, thigh (std.dev.)	3.50	8.00	5.45	3.50	9.50	6.19	5.00	11.50	7.44

* The incidental low producers that appear in the records as yearlings are subject to culling before the breeding season.

** Corrected according to method advanced by Schott, RG., E.M. Pehle, D.A. Spencer and Glenn W. Brier. Wool yields in the small side-sample as related to individual whole-fleece yields in four breed-groups of sheep. Jour. An. Science, Vol.1, No. 2, May, 1942.

*** The density index of wool for fleeces of sheep is the weight in hundredths of a gram of clean dry wool per cubic centimeter of growing staple. (Discontinued in 1942)

	Grease Wool (lbs.)	Clean Wool (lbs.)	Clean Yield (percent)
Targhee	0.6	0.43	1.90
Columbia	0.4	0.37	1.58
Corriedale	0.5	0.28	.85

There is a high relationship between body weight and grease fleece weight and also body weight and scoured fleece weight. There was a positive but low relationship between body weight and fleece length in the Targhee, Columbia and Corriedale breeds.

A STUDY TO DETERMINE THE MOST REPRESENTATIVE AREA FOR SAMPLING IN EACH OF THE TARGHEE, CORRIEDALE AND COLUMBIA BREEDS. Refer to page 30.

CLEAN YIELD AND FINENESS DETERMINATIONS IN ZONED AREA SAMPLES

Five two-year old Columbia ewe fleeces were selected for a fleece zoning study. One-half of each fleece was separated into small portions (zones) and the other one-half was scoured intact. This study was initiated to secure basic information relative to the most representative area on the fleece from which to obtain samples for clean yield and fineness determinations. The analysis of these data has not been completed. This study is being continued in 1942, but with 10 head of yearling Rambouillet ewes.

MOISTURE IN GREASE WOOL. Refer to page 31.

HAIRY BIRTH COAT IN LAMBS. Refer to page 32.

Reports of Sales for Fiscal Year 1942.

Date	Sales Slips Numbers	Description	Amount.
9-8-41	3415-A	4 head surplus Rambouillet rams	$ 160.00
	3416-A	Surplus wool, payment on account	7500.00
9-27-41	3417-A	2 head surplus Rambouillet Rams	50.00
	3418-3421-A	856 head ram, ewe and wether lambs and rams at market	5396.66
10-7-41	3422-3451-A	517 head rams, ram lambs and ewes at annual surplus sale	10750.41
10-17-41	3452-A	347 head ram ewe and wether lambs, rams ewes and wethers at market	2097.82
10-27-41	3453-A	Surplus wool, payment on account	4362.10
10-22-41	3454-3455-A	31 head ram lambs and ewes for slaughter	180.71
1-16-42	3456-A	Surplus wool, payment on account	1020.56
1-20-42	3457-3458-A	Scrap metal and batteries	47.64
	3459-A	Surplus sheep pelts	281.62
2-3-42	3460-A	Grazing fee (leased lands)	66.18
2-11-42	3461-A	Surplus wool (final payment)	509.81
2-12-42	3462-A	1 head surplus Corriedale Ram	50.00
3-17-42	3463-A	3 yrlg. wethers for slaughter	21.66
4-22-42	3464-A	4 head surplus Rambouillet rams	250.00
5-18-42	3465-3479-A	136 head orphan lambs	34.00
6-3-42	3480-3485A	20 head orphan lambs	5.00
6-22-42	3486-A	Scrap rubber	2.43
		TOTAL CASH SALES	$ 32,794.60

Summary:

1203 head of rams, ewes, wethers and lambs sent to market	7,494.48
528 head of rams, ewes and ram lambs sold for breeding stock	11,268.41
34 head of rams, ewes and wethers sold for slaughter	281.62
156 head of orphan lambs sold	39.00
Total receipts from sales of sheep	19,004.26
Total receipts from sales of surplus wool	13,392.47
Total receipts from sales of surplus pelts	281.62
Total receipts from leasing of land	66.18
Total receipts from sales of scrap	50.07
	$ 32,794.60

Add:

Wool from yearling Rambouillet ewes shipped to Miles City, 3698 lbs. @ .4115 for fine wool	1,521.73
Wool transferred to Federal Prison Industries (shipped to Evenson and Levering) 6870 lbs. @.4115 for fine, .4447 for ½ blood, .4252 for 3/8 blood and .4492 for 1/4 blood	2,954.59
Wool trahsferred to Agricultural Marketing Service, 243 lbs. @.4115 for fine, .4447 for 1/2 blood, .4252 for 3/8 blood and .4492 for 1/4 blood	105.14
GRAND TOTAL	$ 37,376.0

	Grease Wool (lbs.)	Clean Wool (lbs.)	Clean Yield (percent)
Targhee	0.6	0.43	1.90
Columbia	0.4	0.37	1.58
Corriedale	0.5	0.28	.85

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